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Banks' Advantage in Hedging Liquidity Risk: Theory and Evidence from the Commercial Paper Market

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ABSTRACT

Banks have a unique ability to hedge against market-wide liquidity shocks. Deposit inflows provide funding for loan demand shocks that follow declines in market liquidity. Consequently, banks can insure firms against systematic declines in liquidity at lower cost than other institutions. We provide evidence that when liquidity dries up and commercial paper spreads widen, banks experience funding inflows. These flows allow banks to meet loan demand from borrowers drawing funds from commercial paper backup lines without running down their holdings of liquid assets. We also provide evidence that implicit government support for banks during crises explains these funding flows.

DURING THE GREAT DEPRESSION, investors responded to banking crises by converting deposits into currency: Between 1929 and 1933, the ratio of deposits to currency fell from about 12 to less than 5 (Friedman and Schwartz (1963)). This disintermediation resulted in a catastrophic contraction in credit (Bernanke (1983)). In contrast, when crises occur today, we observe reintermediation: Instead of credit contracting destructively, it changes form. Funds flow from the market to banks (rather than to currency) as investors seek a safe haven for their wealth. At the same time, large firms that normally use commercial paper (CP) for short-term financing and the bond market for long-term credit turn to banks as their "liquidity provider of last resort."[1]

This paper studies the role of banks in offering liquidity insurance for the CP market, where liquidity refers here to the supply of short-term credit for nonfinancial CP issuers. Since the 1970 Penn Central bankruptcy, CP issuers have

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[1] The rise of the commercial paper market followed by the growth of the junk bond market in the 1980s and 1990s has seemingly reduced the role of banks in providing financing to large businesses (Mishkin and Strahan (1998)). Boyd and Gertler (1994), however, document the increasing importance of unused bank loan commitments over that past 20 years. Berger and Bouwman (2005) document the importance of banks in liquidity production and show that this role has grown sharply over time.

invariably secured a backup line of credit from a bank as protection against declines in liquidity in the CP market. Banks have traditionally provided backup liquidity in the form of loan commitments to many classes of borrowers. In the case of the CP backup lines, these contracts allow firms to borrow (or "take down") up to a predetermined amount of funds at a fixed spread over a safe market benchmark interest rate such as London Inter Bank Offered Rate (LIBOR).

Why do commercial banks, as opposed to other financial institutions, provide this liquidity insurance? In this paper, we argue that banks can provide firms with insurance against market-wide liquidity shocks in the CP market—that is, unexpected and across-the-board decreases in the supply of short-term credit—at lower cost than other financial intermediaries because deposit inflows provide a hedge for loan demand shocks. During normal times (high liquidity in the CP market), funds flow directly from investors to firms. Because banks are viewed as a safe haven by investors, funding tends to become available to them during periods of market stress (low liquidity), just when borrowers want to draw funds from their loan commitments. Hence, the funding flows within a bank offset each other, with deposit inflows serving as a hedge for outflows from loan commitment takedowns. Because of this hedge, banks can offer the lowest cost insurance against a systematic shock to liquidity in the CP market. The ability of banks 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 that of Kashyap, Rajan, and Stein (2002) (KRS), who propose a risk management motive to explain why commercial banks combine demand deposits with loan commitments or lines of credit (we use these last two terms synonymously).[2] In effect, banks offer liquidity to both households and firms with these products. As long as the demand for liquidity from depositors and borrowers is not too highly correlated, the intermediary will 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 takedowns.[3] Our argument extends the KRS rationale to highlight the unique ability of banks to hedge against systematic liquidity shocks. As a result, banks can insure firms against market-wide declines in the availability of liquidity at lower cost than other institutions.[4]

[2] Some early studies analyze loan commitments as a hedge against changes in interest rates or credit quality (see, e.g., Thakor (1982) and Kanatas (1987)), and others analyze the pricing structure of loan commitments as a way to separate high-quality from low-quality borrowers (see, e.g., Boot, Thakor, and Udell (1987) and Thakor and Udell (1987)). Other studies emphasize loan commitments as protection for borrowers against credit rationing by their bank (see, e.g., Berger and Udell (1992) and Morgan (1998)). For more recent studies on the 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)). Garber and Weisbrod (1990) argue that banks also have an advantage due to their ability to move liquid assets between banks efficiently, thereby lowering the amount of cash that any individual bank needs to hold.

[4] Our argument provides another dimension of "bank specialness," which is derived from the combination of access to safety net protection during periods of market shocks and the nature of the deposit-taking franchise. Previous research identifies several other dimensions of bank specialness,

Section I below provides some background by describing the liquidity insurance role of banks in the CP market, and outlines a simple model showing how the correlation between a lender's funding cost and the availability of market liquidity affects its ability to price this insurance. The price of loan commitments varies negatively with the covariance between the cost of funds to the lender and the availability of market liquidity. Because banks, but not competing intermediaries, have funding inflows that co-vary negatively with market liquidity, only they can offer this product in a competitive equilibrium. This is the main testable hypothesis that drives our model.

In Sections II and III, we show empirically that bank funding costs decrease when market liquidity becomes scarce, where liquidity is measured by the difference between the CP rate to high-grade borrowers and the Treasury bill rate, that is, the "paper-bill spread." We provide several pieces of supporting evidence. First, we show that bank asset growth increases in response to widening of spreads in the CP market, controlling for the overall level of interest rates. Moreover, the increase in assets occurs not only in the loan and commercial and industrial (C&I) loan portfolios 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 face of unexpected increases in loan demand alone, banks increase their holdings 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 transactions deposits) increases with the paper-bill spread, reflecting the increased availability of deposit finance during periods of high spreads. Third, we test how the funding costs of banks versus finance companies changes with the CP spread. We find that yields on bank-issued paper (i.e., large negotiable certificates of deposit (CDs)) decreases with the CP spread, whereas yields on finance-company-issued paper do not. This differential response to CP 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 use bank-level panel data to demonstrate that the increase in lending and deposits that occurs with CP market tightness is concentrated at banks with a high level of preexisting loan commitments. In contrast, the increase in liquid assets occurs at banks across the board, regardless of their level of preexisting loan commitments. Moreover, we find no effect of market tightness on nondeposit funds. Similarly, inflows of funds do not reflect a bank's own financial risk, as measured by its capital-asset ratio.

emphasizing a link between the liability side and the asset side of banks. For example, Fama (1985) suggests 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). Berlin and Mester (1999) argue that banks' access to inelastically supplied funds (core deposits) allows them to offer borrowers insurance against credit shocks. 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)).

Taken together, these results suggest that banks in general experience deposit inflows during periods of high spreads. We interpret this as evidence that implicit backing of bank deposits by the government explains their ability to raise cheap funds when other financial institutions cannot, thereby explaining the advantage to banks of offering insurance against market-wide declines in liquidity. Pennacchi (2005) finds no evidence that funds flowed into the banking system when spreads widened during the 1920s, prior to the expansion of the federal safety net with the creation of federal deposit insurance.

I. Banks' Insuring Liquidity in the CP Market

Under normal circumstances, CP offers the lowest cost source of short-term financing for large, well-established firms. The CP backup line of credit, however, allows a firm to borrow from its bank at a predetermined spread, thus providing insurance against the possibility of having to borrow (e.g., because outstanding paper is maturing) when CP is expensive. Borrowing in the CP 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.

The role of banks as liquidity insurance providers originated early in the development of the CP market. In 1970, Penn Central Transportation Company filed for bankruptcy with more than $80 million in CP outstanding. As the result of this default, investors lost confidence in other large CP issuers, making it difficult for some of these firms to refinance their paper as it matured. The Federal Reserve responded to the Penn Central crisis by lending aggressively to banks through the discount window and encouraging them, in turn, to provide liquidity to their large borrowers (Kane (1974)). In response to this difficulty, CP issuers thereafter began purchasing backup lines of credit from banks to insure against future funding disruptions (Saidenberg and Strahan (1999)).

Similar market shocks have happened periodically since the Penn Central debacle. Typically, some event in the markets lowers investor confidence in the 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 CP 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 commercial-paper

[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.

> 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 CP, corporate bonds, or equities.

In the Appendix, we present a simple asset-pricing model of loan commitments in which firms potentially bear the risk of supply shocks in the CP market. Loan commitments (i.e., CP backup lines) effectively complete the market for CP issuers, thereby allowing them to hedge the risk of these funding supply shocks. The model highlights why banks' funding behavior allows them to dominate the market for backup liquidity. Specifically, we show in Proposition 1 that an intermediary (such as a bank) whose funding cost declines when market liquidity becomes scarce, that is, when the supply of funds to CP issuers declines, has a comparative advantage over competing intermediaries. Thus, banks can offer lower prices for backup liquidity than financial intermediaries whose funding costs do not decline when liquidity evaporates.

We next show empirically that banks, as opposed to competing finance companies, experience inflows of funds and lower funding costs when the CP market tightens, at the same time that CP issuers have a high demand to take down funds from their backup lines of credit. In other words, 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). Thus, reintermediation occurs during periods of market turmoil because investors trust banks.

II. 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, where liquidity refers to the supply of short-term credit for nonfinancial CP issuers. We report aggregate time-series evidence that bank assets grow faster when the paper-bill spread is high than when it is low. This accelerated growth occurs not only in lending but also in

[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.

banks' holdings of cash and securities. The increases in asset growth suggest that as demand for bank loans increases (in response to the higher cost of borrowing in markets), so does the supply of funding (hence liquid assets rise rather than fall).[7] We then look at the other side of the balance sheet, testing how banks fund their increased growth. We find that deposits, and especially transactions 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 decrease with the spread, suggesting better funding availability to banks, whereas yields on finance company paper do not decrease.

We suggest two reasons why the paper-bill spread, our measure of liquidity supply, may widen during a liquidity event. First, there could be a general flight to quality in which investors become willing to hold only very safe assets such as T-bills and bank deposits. Borrowers thus become cut off from the CP market, spreads widen, and they turn to their bank for credit. A second interpretation is that systemic events (such as the Russian default) reduce investor confidence in the ability to separate high-risk from low-risk firms. Such an increase in information asymmetry (opaqueness) aggravates moral hazard and adverse selection problems that can lead to equilibrium credit rationing (e.g., Stiglitz and Weiss (1981)). As in the flight to quality interpretation, investors withdraw funds from markets and invest in banks because of the perceived safety of banks. Firms draw funds from their backup lines to replace the liquidity no longer supplied by the market. Banks, with information not available to arm's length investors, are able to distinguish among borrowers (despite the systemic event) and hence continue to supply credit even when the markets cannot.

While these are two slightly different explanations for the cause of the reduction in market liquidity, our purpose is not to explain changes in market liquidity but rather to illustrate why banks offer liquidity insurance better than other intermediaries. As we have argued, the advantage of banks stems from funding inflows that provide a natural hedge against liquidity shocks. Whether or not banks need to have better information than markets—they would not under the simple flight to quality story but would under the increased opaqueness story—is less crucial for us. Information collection is presumably something that intermediaries do better than individual investors (or passive money market mutual funds), but we see no obvious reason why banks would be better at information production than other intermediaries such as finance companies or insurance companies. In other words, information is not what lies behind the comparative advantage of banks in this market.[8] For our purposes, what is important is finding an empirical measure of the supply of liquidity.

[7] We also find that asset growth increases with spreads at all banks, whereas lending grows faster in response to tight spreads only at banks with high levels of preexisting loan commitments. See Section IV.

[8] Information is not likely to explain the advantage of banks in offering liquidity insurance because finance companies extend credit to firms with at least as much opaqueness as banks (Carey, Post, and Sharpe (1998)).

A. Methods and Data

Our use of the paper-bill spread is motivated by Covitz and Downing (2002), who argue that yields on short-term CP capture both liquidity risk as well as default risk, whereas yields on long-term bonds reflect only default risk. To address the possibility of default risk confounding our results, we include systematic default risk controls (the AAA-Baa long-term bond yield spread in one case, and the AA-A2/P2 short-term CP spread in the other) in robustness tests of our main regression results. These results confirm the intuition that short-term changes in the paper-bill spread reflect changes in the availability of market liquidity rather than rapid and short-lived changes in default risk.

The difficulty with our tests is that shocks in the CP market have historically been dramatic but brief. In Section II, we describe instances in which CP 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. Figure 1 plots the paper-bill spread during our sample period, from 1988 to 2002. It shows that 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, CP 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, CP spreads rose from 68 basis points to 118 basis points in just 2 weeks. But by the beginning of November, the spreads had fallen back to 65 basis points.

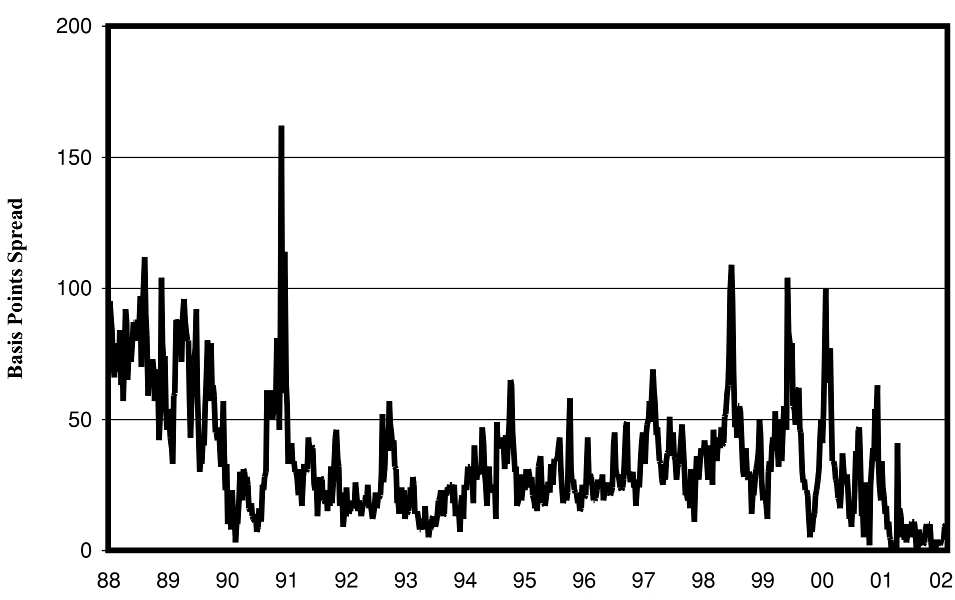

Figure 1. Paper-bill spread, 1988–2002. Yield on 3-month T-bill minus 3-month high-grade commercial paper.

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 the interesting variation in the paper bill 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 the banking system that is available.[9] The weekly banking data are matched to interest rates on short-term (3-month) government securities and CP rates. Our measure of market tightness, or the cost of market-provided liquidity, equals the spread between the 3-month CP rate for highly rated (AA) nonfinancial borrowers and the 3-month T-bill rate.

To test how market liquidity affects the banking system, we estimate a series of vector autoregressions (VARs), each including three variables, namely, one representing growth in the banking system and the other two reflecting interest rates. In particular, on the asset side we model the change in bank assets, the change in loans (total loans and C&I loans), or the change in liquid assets (cash plus securities); on the liability side we model the change in deposits, the change in transactions deposits, the change in large time deposits, or the change in nontransactions deposits. Each of these change variables is normalized by beginning-of-period assets.

We also report VARs with the change in the yield on large, negotiable certificates of deposit and with the change in the yield on short-term borrowing by finance companies. These results allow us to test how the cost of funds for banks varies with market liquidity in comparison with their closest competitors. As the most direct comparison of funding costs for banks versus finance companies, we also test how the difference between the yield on large CDs and finance company paper responds to market liquidity shocks.

The interest rate variables that we include in each VAR system are the change in short-term interest rates (the 3-month Treasury rate), and the spread between the CP rate and this short-term interest rate.[10] Summary statistics for the banking system growth rates and the interest rate variables appear in Table I.[11]

[9] We use the data from the 50 weekly reporting banks, not seasonally adjusted, from 1988 to 2002. These data come from the Federal Reserve Board's website, and reflect the activity of the 50 largest U.S. banks.

[10] We first difference all the interest rate series because each has a very high degree of persistence. For example, the 3-month T-bills and the 5-year Treasury notes have MacKinnon-approximate p-values for the Phillips–Perron tau-statistics of 0.92 and 0.67, respectively, that is, the unit-root null is not rejected. Differencing removes the possibility of generating spurious results stemming from the presence of a unit root. For example, differencing the above series allows us to reject the unit-root null with p-values of less than 0.001. Finally, the hypothesis that the paper-bill spread has a unit root is rejected; for example, the CP spread has MacKinnon-approximate p-values of 0.00 for the Phillips–Perron tau-statistics.

[11] We also try including a term structure variable equal to the difference in the yields on 5-year Treasury notes and the 3-month Treasury bill. Adding this variable has little effect on the results.

Table I

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, 1988–2002. Also reported is the paper-bill spread, defined as the 3-month commercial paper rate for highly rated borrowers minus the 3-month Treasury bill rate, the 3-month Treasury bill rate, and the rates on large bank CDs and finance-company paper. Interest rate data are from the Federal Reserve Board of Governors. All figures are measured in percentage points.

	25th Percentile	Median	75th Percentile
ΔAssets/Assets$_{t-1}$	−0.73	0.10	0.87
ΔLoans/Assets$_{t-1}$	−0.16	0.02	0.24
ΔC&I loans/Assets$_{t-1}$	−0.06	−0.004	0.07
ΔLiquid assets (cash + securities)/Assets$_{t-1}$	−0.43	0.01	0.53
ΔDeposits/Assets$_{t-1}$	−0.77	−0.05	0.94
ΔTransactions deposits/Assets$_{t-1}$	−0.68	0.02	0.67
ΔNontransactions/Assets$_{t-1}$	−0.25	−0.04	0.18
ΔLarge time deposits/Assets$_{t-1}$	−0.06	−0.005	0.05
ΔAnnual yield on 3-month Treasury bill	−0.06	0	0.05
ΔAnnual yield on 3-month rate on negotiable CDs	−0.04	0	0.03
ΔAnnual yield on three-month rate on finance paper	−0.03	0	0.04
Yield on negotiable CDs—yield on finance paper	−0.02	0	0.02
Paper—bill yield spread	0.18	0.29	0.44

B. Results

Table II summarizes the VAR results for growth in the banking system, with Panel A reflecting asset-side growth and Panel B liability-side growth. Table III then reports the VAR statistics for the models of bank and finance company funding costs. For each VAR, we also report the impulse response function for a shock to the CP spread as a convenient way to understand the economic magnitude and timing of how liquidity shocks affect the banking system (Figures 2–4).

The first set of results (Table II, Panel A) indicates that there is a substantial effect of the paper-bill spread on subsequent growth in the banking system. For example, the Granger-causality tests show that the paper-bill spread has incremental explanatory power in predicting subsequent bank asset growth, as well as growth in particular assets. The increased growth rates of both lending and liquid assets (cash + securities) strongly suggest that funding supply increases when market spreads widen; otherwise, banks would fund the increased demand for loans (by firms wanting to take down funds from CP backup lines) by running down their holdings of liquid assets. To understand the magnitude of these effects, the impulse response of the asset growth rate suggests that an increase of 26 basis points (the difference between the 75th and the 25th percentiles) in the paper-bill spread would be associated with an increase in asset growth of 0.40% in the following week. This asset growth increase is large

Table II

Vector Autoregressions (VARs) of Weekly U.S. Banking System Growth Rates on the Paper-Bill Spread and Interest Rates

Granger causality Wald tests and impulse response functions for VARs with three equations. There is one equation for the asset variable. The other two equations are for the paper-bill spread and the change in the 3-month Treasury bill rate. Each VAR is estimated with four lags. We report the χ^2 statistic testing the null that all the coefficients equal zero. For each VAR, we also report a corresponding impulse response function to quantify the impact of a standard-deviation innovation in the paper-bill spread on the growth in bank balance sheets. The sample is based on weekly data over 1988–2002, from the Federal Reserve Board's H.8 statistical release. See Table I for summary statistics.

Panel A: Asset Growth

Equation	Excluded	χ^2	p-Value
	Granger Causality Wald Tests		
Asset growth VAR			
ΔAssets/Assets$_{t-1}$	Paper-bill spread	19.19	0.0007
Paper-bill spread	ΔAssets/Assets$_{t-1}$	10.38	0.0344
Loans VAR			
ΔLoans/Assets$_{t-1}$	Paper-bill spread	20.53	0.0004
Paper-bill spread	ΔLoans/Assets$_{t-1}$	11.81	0.0188
C&I loans VAR			
ΔC&I loans/Assets$_{t-1}$	Paper-bill spread	14.75	0.0053
Paper-bill spread	ΔC&I loans/Assets$_{t-1}$	7.59	0.1080
Liquid assets VAR			
ΔLiquid assets/Assets$_{t-1}$	Paper-bill spread	8.45	0.0765
Paper-bill spread	ΔLiquid assets/Assets$_{t-1}$	15.91	0.0031

	Week	ΔAssets/ Assets$_{t-1}$	ΔLoans/ Assets$_{t-1}$	ΔC&I loans/ Assets$_{t-1}$	ΔLiquid Assets/ Assets$_{t-1}$
		Impulse Response Functions			
Impulse	1	0.01524	0.00344	0.00108	0.00642
Responses	2	−0.00611	−0.00015	−0.00036	−0.00340
	3	0.00319	0.00299	0.00085	−0.00157
	4	−0.00317	−0.00029	0.00004	−0.00053

Panel B: Liability Growth

Equation	Excluded	χ^2	p-Value
	Granger Causality Wald tests		
Deposits VAR			
ΔDeposits/Assets$_{t-1}$	Paper-bill spread	22.87	0.0001
Paper-bill spread	ΔDeposits/Assets$_{t-1}$	15.84	0.0032
Transaction deposits VAR			
ΔTransact dep/Assets$_{t-1}$	Paper-bill spread	24.68	0.0001
Paper-bill spread	ΔTransact dep / Assets$_{t-1}$	13.82	0.0079
Nontransaction deposits VAR			
ΔNontransact/Assets$_{t-1}$	Paper-bill spread	8.45	0.0765
Paper-bill spread	ΔNontransact/Assets$_{t-1}$	5.25	0.2628
Large time deposits VAR			
ΔLarge time dep/Assets$_{t-1}$	Paper-bill spread	16.96	0.0020
Paper-bill spread	ΔLarge time dep/Assets$_{t-1}$	1.39	0.8456

	Week	ΔDeposits/ Assets$_{t-1}$	ΔTransact Dep/ Assets$_{t-1}$	ΔNontransact/ Assets$_{t-1}$	ΔLarge Time Dep/ Assets$_{t-1}$
		Impulse Response Functions			
Impulse	1	0.01396	0.01388	0.00077	0.00056
Responses	2	−0.00261	−0.00392	0.00065	0.00085
	3	0.00151	−0.00154	0.00254	0.00098
	4	−0.00735	−0.00431	−0.00073	0.00025

Table III
Vector Autoregressions (VARs) of Weekly Changes in Bank and Finance Company Marginal Funding Cost on the Paper-Bill Spread and Interest Rates

Granger causality Wald tests and impulse response functions for VARs with three equations. There is one equation for the asset variable. The other two equations are for the paper-bill spread and the change in the 3-month Treasury bill rate. Each VAR is estimated with four lags. We report the χ^2 statistic testing the null that all the coefficients equal 0. For each VAR, we also report a corresponding impulse response function to quantify the impact of a standard-deviation innovation in the paper-bill spread on the growth in bank balance sheets. The sample is based on weekly data over 1988–2002, from the Federal Reserve Board's H.8 statistical release. See Table I for summary statistics.

Granger Causality Wald Tests

Equation	Excluded	χ^2	p-Value
ΔYield on large CD VAR			
ΔYield on large CDs	Paper-bill spread	12.75	0.0125
Paper-bill spread	ΔYield on large CDs	57.65	0.0000
ΔYield on finance paper VAR			
ΔYield on finance company paper	Paper-bill spread	13.23	0.0102
Paper-bill spread	ΔYield on finance company paper	14.57	0.0057
Yield differential VAR			
Yield on large CDs—yield on finance paper	Paper-bill spread	15.75	0.0034
Paper-bill spread	Yield on large CDs—yield on finance paper	15.96	0.0031

Impulse Response Functions

	Week	ΔYield on Large CDs	ΔYield on Finance Company Paper	Yield on Large CDs—Yield on Finance Paper
Impulse	1	−0.23776	0.09730	−0.01006
Responses	2	−0.08887	−0.06112	−0.09286
	3	0.19436	0.15753	0.08751
	4	−0.09037	−0.06648	−0.02617

relative to the median weekly growth rate in bank assets of 0.10%. For the growth of liquid assets, a 26 basis point rise in the spread is associated with an increase in the growth of liquid assets of 0.17%.

The impulse responses also indicate little persistence in the effects of tightening spreads on lending. In the lending equations, the responses beyond 1 week are small: The second-week response of loan growth to the 26 basis point paper-bill rate increase is only about −0.004% (Figure 2). Overall, periods further out into the future have rapidly declining responses. Increases in market spreads only raise the growth rate of bank loans during the period of tight markets; once the market spreads decline, the growth rates quickly

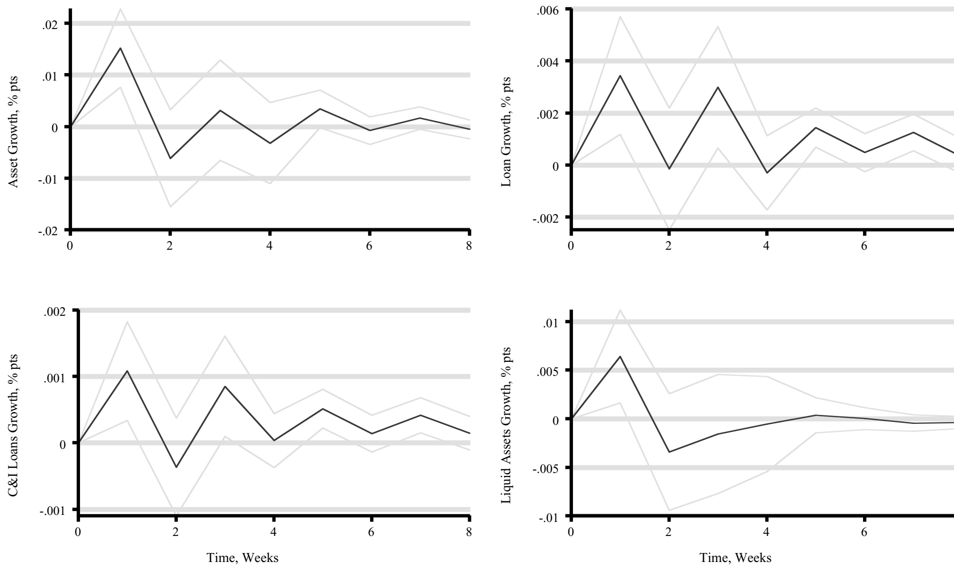

Figure 2. Assets' responses to a commercial paper (CP) spread shock. The figure reports the effect of a standard-deviation increase in the CP spread on the weekly growth in assets from an autoregression (VAR) model with four lags of bank asset growth, Treasury bill rates, and the paper-bill spread.

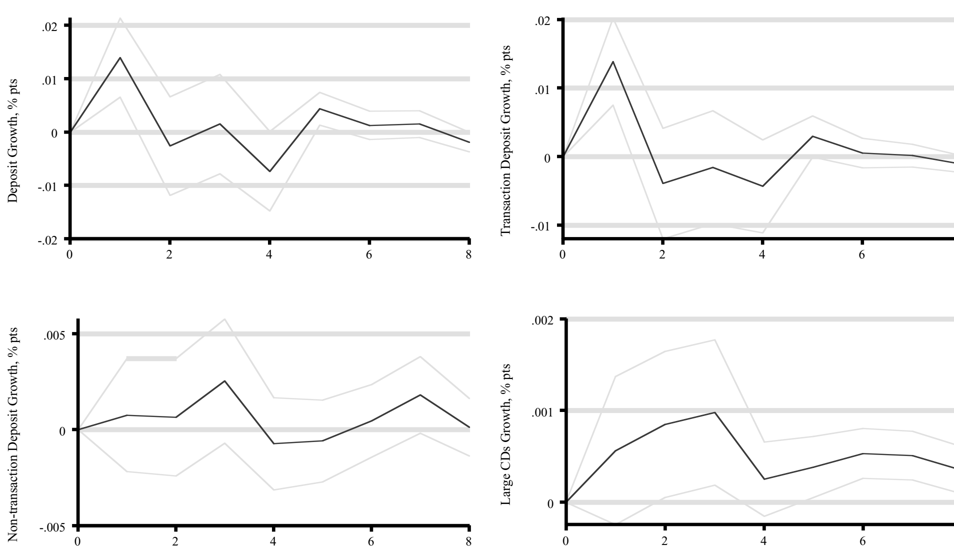

Figure 3. Liabilities responses to a commercial paper (CP) spread shock. The figure reports the effect of a standard-deviation increase in the CP spread on the weekly growth in liabilities from a VAR model with four lags of bank liability growth, Treasury bill rates, and the paper-bill spread.

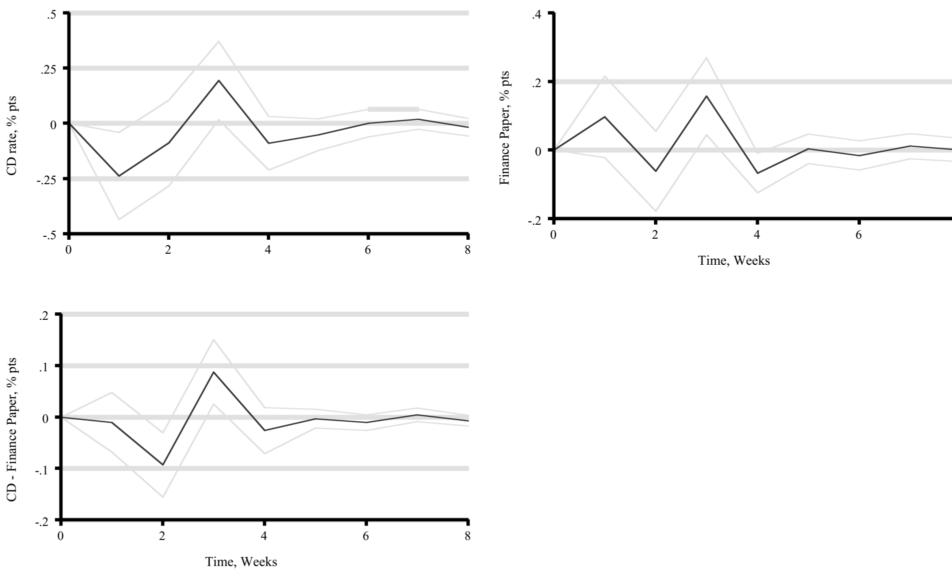

Figure 4. Rates' responses to a commercial paper (CP) spread shock. The figure reports the effect of a standard deviation increase in the CP spread on the weekly growth in interest rate spreads from a VAR model with four lags of interest rate spreads, Treasury bill rates, and the paper-bill spread.

revert to their average levels. In the liquid asset growth equation, the subsequent impulse response effects are also negative but much larger, with a second-week response of about −0.09%. 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 a change in market spreads. The declining responses mean that once the spread reverts to normal, liquid assets actually grow substantially more slowly than normal or even shrink, thereby allowing the banking system to return to the desired holdings of liquid assets rapidly.

In Panel B of Table II, we test how bank funding changes with the paper-bill spread. These results suggest that the increase in asset growth is funded with additional deposits, particularly transaction deposits, and are consistent with our basic story of funding availability shifting from the capital markets to the banking system (Figure 3).

In Table III, we estimate a VAR that includes the change in the yield on large, 3-month negotiable certificates of deposit and the change in the Treasury bill rate, along with the paper-bill spread. In addition, we estimate a parallel VAR using the change in the 3-month finance paper rate. The results provide further evidence that bank funding availability increases as the CP spreads widen. The reliance of banks on transaction deposits increases with the paper-bill spread, and at the same time, the yield on large CDs declines. The coefficient suggests that a 26 basis point increase in the CP spread is followed by a decline in the bank CD rate of about 6 basis points. In contrast, funding costs for finance companies (such as GE Capital) actually increase slightly just after the shock.[12] In the VAR with the difference between the CD rate and the finance company rate changes, we find declines in the first 2 weeks following the shock to the CP spread, after which time the spread change increases, bringing it back to its long-run level (Figure 4).

C. Robustness Tests

Taken as a whole, our results so far suggest a shift in the willingness of investors to hold bank deposits, presumably perceived to be safe, relative to CP (or finance company paper), during periods of weak investor confidence. What explains the simultaneous widening of market spreads and funding flows into the banking system? Our view is that during periods of concern about market integrity, that is, when spreads rise, the perceived value of the government safety net increases, as does the perceived likelihood of a bailout (or support) of the banking system. This idea seems particularly relevant to understanding the events following the Russian default and the fall of LTCM (Gatev, Schuermann, and Strahan (2005)). (As further support for this safety net view, we show below that increased funding following shocks to the CP spread is no greater at banks with high capital-asset ratios (safe banks) than at banks with low capital-asset ratios (risky banks).) In addition, this notion can explain both increases in deposit funding (because concerned investors flee to banks) and declines in yields on uninsured deposits (because an increased bailout probability reduces the risk of uninsured deposits). Of course, funding flows into the banking system can be directly facilitated by the central bank through its operation of monetary policy, either directly (with discount window lending) or with open market operations (to support increases in bank deposits).[13] Increases in systematic credit risk, or more generally, declines in market sentiment, could also play a role in explaining why investors might seek a safe haven for their funds.

Table IV shows that our results are robust to variables that could potentially explain the funding supply shifts from the capital markets to the banking system that are associated with changes in monetary policy, transaction liquidity (availability of a willing counterparty), systematic credit risk, or sentiment. We rule out these alternatives by testing whether our main findings are robust to the inclusions of the following proxy variables: (1) for monetary policy, the growth in total reserves at the Fed in one case or the change in the federal funds rate in the other; (2) as a measure of transaction liquidity, the on-the-run/off-the-run spread for the 30-year bond (Krishnamurthy (2001)); (3) as proxies for

[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. All pricing effects documented here are transitory, consistent with the notion of accommodating a supply shock.

[13] Discount window lending by the Fed to commercial banks is almost never quantitatively significant throughout our sample period. The one exception is that the Fed did use the discount window to supply a significant quantity of liquidity during the days following the attack on the World Trade Center (McAndrews and Potter (2002)).

credit risk, the AAA-Baa long-term bond spread or the AA-A2/P2 short-term CP spread; and (4) as a measure of sentiment, the implied volatility of the S&P 100 from options prices (the VIX index).

The results show that the paper-bill spread continues to drive the results in the presence of these potentially omitted factors. The proxy variables are

Table IV

Robustness Tests for Omitted Variables

Granger causality Wald tests for autoregressions (VARs) with four equations. Equation one is for one of the following potentially omitted variables: (1) the growth in bank reserves; (2) the change in the Federal funds rates; (3) the on-the-run/off-the-run spread for 30-year Treasuries; (4) the implied volatility for the S&P 100; (5) the spread between AAA and Baa corporate bonds; and (6) the spread between the AA-rated and the A2/P2-rated commercial paper rates. There is one equation for the asset or liability variable. The other equations are for the paper-bill spread and the change in the 3-month Treasury bill rate. Each VAR is estimated with four lags. We report the χ^2 statistic and p-value testing the null that all the coefficients equal 0. The sample is based on weekly data over 1988–2002, from the Federal Reserve Board's H.8 statistical release. See Table I for summary statistics.

Panel A: Asset Growth and Liability Growth

	Equation			
Potentially Omitted Variable (top row)	ΔAssets/ Assets$_{t-1}$	ΔLoans/ Assets$_{t-1}$	ΔDeposits/ Assets$_{t-1}$	ΔTransact Dep/ Assets$_{t-1}$
(1) Growth in bank reserves	5.79	6.90	3.38	10.91
	(0.2154)	(0.1411)	(0.4963)	(0.0275)
Paper-bill spread	18.03	20.27	22.32	23.36
	(0.0012)	(0.0004)	(0.0002)	(0.0001)
(2) Change in Fed funds rate	5.16	5.83	6.38	3.29
	(0.2708)	(0.2119)	(0.1721)	(0.5096)
Paper-bill spread	19.70	20.53	19.93	23.64
	(0.0006)	(0.0004)	(0.0005)	(0.0001)
(3) On-the-run/Off-the-run spread	14.96	4.23	6.54	10.03
	(0.0048)	(0.3763)	(0.1626)	(0.0399)
Paper-bill spread	15.11	19.26	18.22	26.08
	(0.0045)	(0.0007)	(0.0011)	(0.0000)
(4) Implied volatility on S&P 100	3.8763	4.62	6.78	4.31
	(0.4230)	(0.3282)	(0.1481)	(0.3659)
Paper-bill spread	19.26	19.71	24.91	27.95
	(0.0007)	(0.0006)	(0.0001)	(0.0000)
(5) Yield spread AAA-Baa	14.49	26.50	2.93	3.03
corporate bonds	(0.0059)	(0.0000)	(0.5698)	(0.5534)
Paper-bill spread	21.54	33.05	21.43	22.96
	(0.0002)	(0.0000)	(0.0003)	(0.0001)
(6) AA-A2/P2 spread	9.83	11.35	22.02	19.32
	(0.0434)	(0.0229)	(0.0002)	(0.0007)
Paper-bill spread	12.92	15.93	16.89	17.47
	(0.0117)	(0.0031)	(0.0020)	(0.0016)

(continued)

Table IV—*Continued*

Panel B: Bank and Finance Company Marginal Funding Cost

Potentially Omitted Variable (top row)	Equation: ΔYield on Large CDs	Equation: ΔYield on Finance Paper	Equation: Yield Large CD—Yield on Finance Paper
(1) Growth in bank reserves	1.69	3.89	3.81
	(0.7926)	(0.4206)	(0.4317)
Paper-bill spread	11.79	13.91	16.03
	(0.0190)	(0.0076)	(0.0030)
(2) Change in Fed funds rate	1.29	1.80	1.17
	(0.8627)	(0.7730)	(0.8837)
Paper-bill spread	13.08	14.16	12.95
	(0.0109)	(0.0068)	(0.0115)
(3) On-the-run/Off-the-run spread	5.44	6.20	3.79
	(0.2453)	(0.1845)	(0.4354)
Paper-bill spread	20.43	23.12	14.40
	(0.0004)	(0.0001)	(0.0061)
(4) Implied volatility on S&P 100	3.81	7.46	1.73
	(0.4320)	(0.1137)	(0.7859)
Paper-bill spread	11.44	12.30	16.18
	(0.0220)	(0.0153)	(0.0028)
(5) Yield spread AAA-Baa corporate bonds	3.93	5.86	0.67
	(0.4151)	(0.2100)	(0.9550)
Paper-bill spread	12.13	11.69	15.23
	(0.0164)	(0.0199)	(0.0043)
(6) AA-A2/P2 spread	28.04	22.73	6.32
	(0.0000)	(0.0001)	(0.1763)
Paper-bill spread	13.64	11.91	15.40
	(0.0085)	(0.0180)	(0.0039)

generally not useful in predicting the variables of interest.[14] The exceptions are the on-the-run/off-the-run spread and the credit spreads, which are both useful in predicting overall bank asset growth. Inclusion of these variables, however, does not eliminate the importance of the paper-bill spread, nor does it change the shape or magnitude of the impulse response function.

III. Empirical Evidence: Bank-Level Reaction to Market Spreads

The aggregate analysis offered thus far suggests that banks enjoy cheap funding when the CP market tightens. Next, we use bank-level rates of asset and liability growth to infer how loan takedown behavior and funding vary across banks in response to interest rate and paper-bill spread changes. We also test whether better capitalized banks and larger banks experience greater funding inflows when spreads widen.

[14] The results (not reported here) also show that overall, the proxy variables are not useful in predicting the paper-bill spread.

Direct data on actual loan takedowns from loan commitments are not available. However, we can observe overall loan growth at quarterly frequency, and test whether those banks with more preexisting loan commitments experience greater increases in loan growth when market spreads widen. If demand for loan takedowns really increases with increases in the CP spread, then we should be able to show that banks with more preexisting loan commitments react more to market shocks than other banks. At the same time, the growth in liquid assets with the CP spread observed in the aggregate data ought to occur at all banks, regardless of their level of loan commitments: An across-the-board growth in liquid assets would reflect the better funding availability to banks in general. We also test whether deposit flows tend to increase more at banks with high levels of loan commitments when spreads tighten. We then compare the response of deposits to nondeposit liabilities and foreign deposits, which may be viewed as having less safety net protection than domestic deposits.[15]

We construct a panel data set for all banking organizations using data from 1991 to 2000.[16] Rates of change in assets, loans, and securities are obtained from the *Reports of Income and Condition* (the Call Report). As noted above, ideally we would like to observe the data at a higher frequency, but detailed bank-level data are not available beyond quarterly intervals. The sample begins in the first quarter of 1991 because the banking agencies only began to collect data on unused loan commitments at that time.

The panel data set is unbalanced due to merger and acquisition (M&A) activity that occurred during the sample period. We drop observations in which a banking organization's total assets grew by more than 10% during a single quarter. In this way, we can be sure that large changes in a bank's operations stemming from its M&A activity do not skew our results. In addition, because the dependent variables are growth rates, there are substantial outliers in the panel. We therefore winsorize the data at the 1st and 99th percentiles of the distribution. That is, for each observation that lies *below* the 1st percentile of the distribution, we use the value *at* the 1st percentile; for each observation that lies *above* the 99th percentile of the distribution, we use the value *at* the 99th percentile.[17]

Table V reports the summary statistics for the variables in the panel data set. The quarterly growth in assets average (median) 1.2% across banks and time, and the interquartile range varies from −0.7% to 3.3%. For the quarterly change in loans (normalized by assets), the distribution exhibits slightly less

[15] While foreign deposits are de facto insured by the FDIC, there may be less confidence among foreigners that all their claims would be insured. This concern may be most relevant for large depositors, whose accounts are not fully covered.

[16] Following Kashyap et al. (2002), we use the banking organization as the relevant unit of observation rather than the bank. This means that we first aggregate the bank-level data from the call report up to the holding company level. For example, for a bank holding company owning two banks, we would sum the balance sheet items for each bank first and create a single observation reflecting this banking company's balance sheet (and off balance sheet) characteristics.

[17] Our statistical conclusions are not affected by winsorizing these data, although the magnitude of the coefficients and standard errors is affected.

Table V

Summary Statistics for Quarterly Bank-Level Panel Data

This table reports summary statistics for growth rates in assets, loans, liquid assets (cash + securities + Fed funds sold – Fed funds purchased), and deposits, along with the ratio of unused loan commitments to unused commitments plus total loans. Changes in loans, liquid assets, deposits, nondeposit liabilities, and foreign deposits are normalized by beginning-of-period assets. Foreign deposits are only available for large banks (over $300 million in assets). The sample is based on a panel of all U.S. banks with assets greater than $100 million for each quarter from 1991 to 2000, from the *Reports of Income and Condition*. All banks with asset growth greater than 10% during a quarter are dropped during that quarter so that large mergers do not skew the growth rates. Since the variables display large outliers, the data have been winsorized at the 1st and 99th percentiles. 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, also averaged over each quarter in the 1991–2000 period.

	25th Percentile	Median	75th Percentile
Quarterly growth in assets	−0.7%	1.2%	3.3%
ΔLoans/Assets$_{t-1}$	−0.3%	1.0%	2.4%
ΔLiquid assets/Assets$_{t-1}$	−1.8%	0.07%	2.1%
ΔDeposits/Assets$_{t-1}$	−0.5%	0.6%	2.5%
ΔNondeposit liabilities/Assets$_{t-1}$	−1.5%	0.2%	1.8%
ΔForeign deposits/Assets$_{t-1}$	−0.7%	0%	0.8%
Unused commitments/(Unused commitments + loans)	0.058	0.109	0.167
Paper-bill spread	0.35	0.40	0.48
Three-month Treasury bill rate	4.05	5.00	5.28

variance than the distribution for asset growth, whereas the change in liquid assets displays substantially more variation, ranging from −1.8% at the 25th percentile to 2.1% at the 75th percentile with a median of about zero. Table V also reports the ratio of unused lines of credit divided by unused lines plus total on-balance-sheet loans. This variable is our measure of the extent to which a bank has promised to provide liquidity insurance to its borrowers. The unused commitments ratio had a median value of 0.109 ranging from 0.058 at the 25th percentile of the distributions to 0.167 at the 75th percentile.

Table VI reports the panel regressions for the three asset-side, rates-of-change variables. We include the same interest rate variables used in the aggregate analysis, but now, rather than using high-frequency data, we use averages over the whole quarter. We also include interaction terms between the interest rate variables and each bank's unused commitment ratio (as of the end of the previous quarter). The coefficients on these interaction terms test whether a bank's response to interest rate shocks changes with the extent of its preexisting loan commitments. Next, we include that bank's beginning-of-period capital-asset ratio and its interaction with the CP spread to test whether banks with lower insolvency risk enjoy larger funding inflows when the CP spread widens. To control for other cross-bank heterogeneity, we include the log of assets as of the beginning of the period, and we include bank-level fixed effects.

We interact log of assets with the CP spread to test whether larger banks experience greater funding inflows when spreads widen relative to smaller banks. Last, we report the models with (in Panel A) and without (in Panel B) quarterly time fixed effects.

As shown in both panels of Table VI, the effects of increases in the paper-bill spread on asset growth and loan growth are greater for banks with more

Table VI

Fixed Effects Regressions of Growth in Assets, Loans, and Liquid Assets on the Paper-Bill Spread, Interest Rates, and Interactions

Each column in this table reports a fixed effects regression of three bank-level variables: the growth in assets, the growth in loans, and the growth in liquid assets. The sample is based on a panel of all U.S. banks with assets greater than $100 million for each quarter from 1991 to 2000, from the *Reports of Income and Condition*. All banks with asset growth greater than 10% during a quarter are dropped during that quarter so that large mergers do not skew the changes in lending and deposits. Since the growth rates display large outliers, these data have been winsorized at the 1st and 99th percentiles. 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, also averaged over each quarter in the 1991–2000 period. Standard errors appear below coefficients. Coefficients denoted "**" are statistically significantly different from 0 at the 5% level; those denoted "*" are statistically significantly different from 0 at the 10% level.

Panel A: No Control for Trends

	Asset Growth	ΔLoans/ Assets$_{t-1}$	ΔLiquid Assets/ Assets$_{t-1}$
Paper-bill spread	0.022*	0.016*	−0.007
	(0.013)	(0.009)	(0.012)
Three-month Treasury bill	0.002**	0.002**	−0.001**
	(0.0002)	(0.0001)	(0.0002)
Unused commitments$_{t-1}$	0.030**	0.112**	−0.124**
	(0.008)	(0.005)	(0.007)
Unused commitments$_{t-1}$*	0.068**	0.066**	−0.012
Paper-bill spread	(0.011)	(0.007)	(0.011)
Unused commitments$_{t-1}$*	−0.002	−0.005**	0.009**
Three-month Treasury bill	(0.0013)	(0.0009)	(0.001)
Capital-asset ratio$_{t-1}$	0.204**	0.060**	0.099**
	(0.013)	(0.009)	(0.013)
Capital-asset ratio$_{t-1}$*	0.003	−0.029	0.011
Paper-bill spread	(0.027)	(0.018)	(0.026)
Log of assets$_{t-1}$	−0.013**	−0.003**	−0.006**
	(0.0006)	(0.0003)	(0.0005)
Log of assets$_{t-1}$*	−0.001	−0.001*	0.0012
Paper-bill spread	(0.001)	(0.0007)	(0.0009)
Firm dummies	Yes	Yes	Yes
Quarterly time dummies	No	No	No
N	110,201	110,201	110,201
Within R^2	0.018	0.026	0.009

(continued)

Table VI—*Continued*

Panel B: Year Fixed Effects

	Asset Growth	ΔLoans/ Assets_{t-1}	ΔLiquid Assets/ Assets_{t-1}
Paper-bill spread	–	–	–
Three-month Treasury bill	–	–	–
Unused commitments$_{t-1}$	0.031**	0.108**	−0.113**
	(0.008)	(0.005)	(0.007)
Unused commitments$_{t-1}$* Paper-bill spread	0.072**	0.062**	−0.004
	(0.011)	(0.007)	(0.010)
Unused commitments$_{t-1}$* Three-month Treasury bill	−0.002*	−0.005**	0.008**
	(0.0013)	(0.0009)	(0.001)
Capital-asset ratio$_{t-1}$	0.199**	0.060**	0.098**
	(0.013)	(0.009)	(0.013)
Capital-asset ratio$_{t-1}$* Paper-bill spread	−0.008	−0.025	−0.010
	(0.027)	(0.018)	(0.026)
Log of assets$_{t-1}$	−0.014**	−0.003**	−0.007**
	(0.001)	(0.0004)	(0.0006)
Log of assets$_{t-1}$* Paper-bill spread	−0.001	−0.001	0.001
	(0.001)	(0.0006)	(0.001)
Firm dummies	Yes	Yes	Yes
Quarterly time dummies	Yes	Yes	Yes
N	110,201	110,201	110,201
Within R^2	0.029	0.045	0.036

preexisting lines of credit. That is, the interaction of the paper-bill spread with the unused loan commitment ratio is statistically significant (at the 1% level). The loan-growth result suggests that banks with more commitments experience more takedown demand when CP spreads widen. Just as in the aggregate analysis, we again see increases in the growth of liquid assets when the paper-bill spread widens, suggesting strong funding availability for banks during periods of market tightness.[18] But we do not see any difference in how the liquid asset growth rates respond to spreads across banks; regardless of their level of loan commitments, all banks experience increases in liquid assets following increases in the CP spread. Another way to interpret the liquid asset (non) result: Banks experiencing strong takedown demand when spreads are high (due to preexisting commitments) do not run down their holdings of liquid assets relative to banks with weaker loan demand (due to low levels of undrawn loan commitments).

The coefficient on initial bank capital is positive and significant for all three variables, but the interaction with the CP spread is not. Thus, there is no evidence that banks with stronger balance sheets—banks that might be perceived to be relatively safe—experience large funding inflows during periods of wider

[18] The increase in liquid asset growth with widened spreads is not evident in the models reported here due to the interaction terms. However, if we drop these interactions from the model, we find a positive and significant coefficient on the paper-bill spread, consistent with the aggregate VAR findings.

spreads. With respect to size, we find that larger banks grow more slowly on average, but there is no evidence that larger banks receive greater funding than smaller banks when CP spreads widen. Despite their potential access to full "too big to fail" safety net protections, large banks do not seem to experience greater funding flows than smaller banks.

Table VII reports similar regressions using three liability-side, rate-of-change variables. We find, consistent with the asset-side changes, that deposits grow

Table VII

Fixed Effects Regressions of Growth in Liabilities on the Paper-Bill Spread, Interest Rates, and Interactions

Each column in this table reports a fixed effects regression of three bank-level variables: change in deposits, nondeposit liabilities, and foreign deposits (available for banks with assets over $300 million). The sample is based on a panel of all U.S. banks with assets greater than $100 million for each quarter from 1991 to 2000, from the *Reports of Income and Condition*. All banks with asset growth greater than 10% during a quarter are dropped during that quarter so that large mergers do not skew the changes in lending and deposits. Since the growth rates display large outliers, these data have been winsorized at the 1st and 99th percentiles. 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, also averaged over each quarter in the 1991–2000 period. Standard errors appear below coefficients. Coefficients denoted "**" are statistically significantly different from 0 at the 5% level; those denoted "*" are statistically significantly different from 0 at the 10% level.

Panel A: No Control for Trends

	ΔDeposits/ Assets_{t-1}	ΔNondeposit Liabilities/Assets_{t-1}	ΔForeign Deposits/ Assets_{t-1}
Paper-bill spread	0.015*	−0.016	−0.031
	(0.008)	(0.013)	(0.043)
Three-month Treasury bill	0.0014**	0.0014**	−0.0008
	(0.0001)	(0.0002)	(0.0011)
Unused commitments$_{t-1}$	−0.018**	−0.010	0.002
	(0.005)	(0.008)	(0.020)
Unused commitments$_{t-1}$*	0.037**	−0.012	−0.073**
Paper-bill spread	(0.007)	(0.011)	(0.032)
Unused commitments$_{t-1}$*	0.002**	0.0015	0.0013
Three-month Treasury bill	(0.0009)	(0.0014)	(0.0033)
Capital-asset ratio$_{t-1}$	0.141**	0.114**	0.076**
	(0.009)	(0.013)	(0.038)
Capital-asset ratio$_{t-1}$*	−0.023	0.026	−0.126
Paper-bill spread	(0.018)	(0.027)	(0.084)
Log of assets$_{t-1}$	−0.006**	−0.007**	−0.0014
	(0.0004)	(0.001)	(0.0018)
Log of assets$_{t-1}$*	−0.0003	0.001	0.005
Paper-bill spread	(0.0006)	(0.001)	(0.003)
Firm dummies	Yes	Yes	Yes
Quarterly time dummies	No	No	No
N	110,201	110,201	4,027
Within R^2	0.015	0.0041	0.0043

(continued)

Table VII—*Continued*

Panel B: Year Fixed Effects			
	ΔDeposits/ Assets$_{t-1}$	ΔNondeposit Liabilities/Assets$_{t-1}$	ΔForeign Deposits/ Assets$_{t-1}$
Paper-bill spread	–	–	–
Three-month Treasury bill	–	–	–
Unused commitments$_{t-1}$	−0.014**	−0.006	0.004
	(0.005)	(0.008)	(0.020)
Unused commitments$_{t-1}$* Paper-bill spread	0.046** (0.007)	−0.011 (0.011)	−0.072** (0.032)
Unused commitments$_{t-1}$* Three-month Treasury bill	0.002* (0.0009)	0.0004 (0.0014)	0.0014 (0.0033)
Capital-asset ratio$_{t-1}$	0.123**	0.113**	0.089**
	(0.009)	(0.014)	(0.040)
Capital-asset ratio$_{t-1}$* Paper-bill spread	−0.018 (0.018)	0.010 (0.028)	−0.141* (0.085)
Log of assets$_{t-1}$	−0.006**	−0.009**	−0.0012
	(0.0004)	(0.001)	(0.002)
Log of assets$_{t-1}$* Paper-bill spread	−0.0003 (0.0006)	0.001 (0.001)	0.004 (0.003)
Firm dummies	Yes	Yes	Yes
Quarterly time dummies	Yes	Yes	Yes
N	110,201	110,201	4,027
Within R^2	0.050	0.0137	0.0132

faster when spreads widen, and that the increase is concentrated at banks with high levels of preexisting loan commitments. In contrast, there is no significant effect of spreads—either linear or interacted with loan commitments—for nondeposit liabilities. This suggests that the funding source with arguably the most secure government safety net protection responds most elastically to widened spreads. In the sample of banks for which we can observe foreign deposits, we find, if anything, a decline with widening spreads.

Taken as a whole, the results indicate that when markets become tight, deposit funding becomes more available. Banks with greater preexisting loan commitments grow faster than other banks as spreads widen because they experience increased takedown demand. Liquid assets (cash + securities) grow faster with widened spreads too, but their growth does not reflect a bank's preexisting level of loan commitments. This suggests that all banks experience an increased supply of funds when markets tighten. Moreover, the funding flows do not reflect a bank's capital-asset ratio, and are concentrated among deposits rather than funding sources that may be viewed as less likely to receive safety net protection (nondeposit liabilities and foreign deposits). We interpret this as evidence that market participants view not just individual banks but the banking system as a safe haven for funds, probably because of explicit and implicit support provided by government safety nets.

IV. Conclusions

We show why banks are well suited to providing liquidity insurance to large borrowers. During periods when CP 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 preexisting lines of credit established during these tight times. Thus, because the funding is available when it is needed, banks can offer this liquidity insurance without having to operate with a large amount of liquid assets—assets that are costly to hold both because they earn low returns and because they exacerbate managerial agency problems. We do not find, however, that finance companies experience better funding supply during tight markets. In our view, funding flows into the banking system during periods of high spreads because implicit and explicit government support of banks enhances the willingness of investors to hold deposits. An increased level of (implicit) support during crises is consistent not only with greater funding flows but also with lower yields on large deposits that are not explicitly insured by the government.

Appendix

The expected return on CP is driven by liquidity risk, as well as default risk and possibly other systematic risks.[19] We assume that in the absence of intermediaries, investors cannot hedge liquidity risk; that is, the risk of funding supply shocks affects the expected returns in the CP market. Hence, such supply shocks (L) introduce a form of market incompleteness. More formally, it is well known (for example, Constantinides (1989)) that under simplifying assumptions such as multinormality, we can write the expected return on CP, r_{CP}, as

$$E[r_{\mathrm{CP}}] = \beta \mathrm{Cov}[r_{\mathrm{CP}}, c] + \gamma \mathrm{Cov}[r_{\mathrm{CP}}, L], \tag{A1}$$

where β is the price of systematic (default or other) risk, γ is the price of liquidity risk, and c is per-capita consumption. Since liquidity shocks make financing costs higher, issuers have incentive to hedge them if intermediaries provide the requisite insurance.

CP backup lines of credit—a kind of loan commitment—offer this liquidity insurance because they allow a firm to use intermediaries to avoid facing the costs of the funding supply shock. As we will show, the funding structure of

[19] Covitz and Downing (2002) argue that movements in yields on short- and long-term corporate debts can only be explained by accounting for liquidity risk as well as default risk. As evidence, they show that yields on commercial paper reflect firm-level liquidity risk as well as default risk, whereas yields on long-term corporate bonds reflect only firm-level characteristics related to default risk. Note also that other risk factors can be added to our model without changing the basic story, although they would not contribute to the comparative advantage of banks in commitment lending.

banks makes them best suited to provide this insurance. For simplicity, we assume that loan commitments are not exposed to any systematic risk.[20] Hence, the competitive equilibrium price of loan commitments is

$$E[r_{\mathrm{LC}}] = \gamma \mathrm{Cov}[r_{\mathrm{LC}}, L]. \tag{A2}$$

The realized return on a loan commitment, r_{LC}, is random and has two components that characterize the typical loan commitment. The first is a fixed return, r_{UD}, which is derived from the prepaid 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, that is, 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 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

$$r_{\mathrm{LC}} = (1-\alpha) r_{\mathrm{UD}} + \alpha (r_L - r_D). \tag{A3}$$

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

$$\mathrm{Cov}[r_{\mathrm{LC}}, L] = \mathrm{Cov}[(1-\alpha) r_{\mathrm{UD}}, L] + \mathrm{Cov}[\alpha r_L, L] - \mathrm{Cov}[\alpha r_D, L]. \tag{A4}$$

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

$$\frac{d\,\mathrm{Cov}(\alpha r_D, L)}{d\,\mathrm{Cov}(r_D, L)}. \tag{A5}$$

We assume 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:[21]

$$(r_D, L) \sim N[(\bar{r}_D, 0), \Sigma],$$

$$\mathrm{Cov}[r_D, L] = \sigma_{r_D, L}. \tag{A6}$$

[20] As before, systematic risk factors can be added to our model without loss of generality.

[21] 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 in which the moments are finite.

When α is twice differentiable and L is normally distributed, Stein's lemma implies that

$$\mathrm{Cov}[\alpha r_D, L] = \frac{\sigma_{r_D L}}{\sigma_L^2} E[\alpha(L)L^2] + E[r_D]E[\alpha(L)L]. \tag{A7}$$

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

$$\frac{d\,\mathrm{Cov}[\alpha r_D, L]}{d\,\sigma_{r_D,L}} = \frac{E[(\alpha(L)L^2)]}{\sigma_L^2} > 0, \tag{A8}$$

because the integrand in the expectation is nonnegative (because $0 < \alpha < 1$). If the market for loan commitment is competitive, profits are eliminated (i.e., $P_{\mathrm{LC}} = 0$), so that we have

$$\begin{aligned} E[r_{\mathrm{LC}}] &= \gamma(A - \mathrm{Cov}[\alpha r_D, L]), \\ A &= \mathrm{Cov}[(1-\alpha)r_{\mathrm{UD}}, L] + \mathrm{Cov}[\alpha_{rL}, L], \end{aligned} \tag{A9}$$

and finally, we obtain the main result in Proposition 1:

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

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

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