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How Do Banks Manage Liquidity Risk?
Evidence from the Equity and Deposit Markets in the Fall of 1998

Evan Gatev, Til Schuermann, and Philip E. Strahan

3.1 Introduction

The rise of the commercial paper market and the subsequent growth of the junk bond market in the 1980s and 1990s have seemingly reduced the role of banks in the financing of large businesses (Mishkin and Strahan 1998). This much-remarked-upon evolution away from banks and toward the securities markets has not rendered banks irrelevant (Boyd and Gertler 1994). While they do provide less funding than before, banks remain important to large firms as providers of liquidity support to the commercial paper market. Banks act as the "liquidity provider of last resort" by promising to offer cash on demand through commercial paper backup lines of credit.[1] This liquidity insurance role became especially notable in the fall of 1998, when many firms turned to their banks to provide liquidity normally supplied by the commercial paper market. During this episode, banks faced a *systematic* increase in the demand for liquidity. This paper studies how banks were able to manage this systematic liquidity risk and thus weather the 1998 crisis successfully.

Banks have traditionally provided liquidity, not only to borrowers with open lines of credit and loan commitments (we use these terms interchangeably), but also to depositors in the form of checking and other transactions accounts. Both contracts allow customers to receive liquidity (cash) on short

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1. Banks also continue to bear significant credit risk through off–balance sheet guarantees such as standby letters of credit.

notice. In fact, a financial intermediary combining these two products offers a reasonable definition of what most scholars and regulators mean by "bank." This liquidity insurance role exposes banks to the risk that they will have insufficient cash to meet random demands from their depositors and borrowers.[2]

To the extent that liquidity demands are *idiosyncratic* and therefore independent across customers, a bank can use scale to mitigate its need to hold cash to meet unexpected liquidity shocks.[3] In fact, Kashyap, Rajan, and Stein (2002) present a model in which a risk-management motive explains the combination of transactions deposits and loan commitments: as long as the demand for liquidity from depositors through the checking account is not highly correlated with liquidity demands from borrowers, an intermediary will be able to reduce its need to hold cash by serving both customers. Thus, their model yields a diversification synergy between demand deposits (or transactions deposits more generally) and loan commitments. As evidence, they show that banks offering more transaction deposits (as a percentage of total deposits) tend also to make more loan commitments (also scaled appropriately). The correlation is robust across all sizes of banks.

A bank offering liquidity insurance may face a problem if, rather than facing *idiosyncratic* demands for cash, it sometimes faces *systematic* increases in liquidity demand. For example, during the first week of October 1998, following the coordinated restructuring of the hedge fund Long-term Capital Management (LTCM), spreads between safe Treasury securities and risky commercial paper rose dramatically. Many large firms were unable to roll over their commercial paper as it came due, leading to a sharp reduction in the amount of commercial paper outstanding and a corresponding increase in takedowns on preexisting lines of credit (Saidenberg and Strahan 1999).[4] As a result of this liquidity shock, banks faced a systematic spike in demand for cash because many of their largest customers wanted funds all at once. Because funding flowed into the banking system, however, this systematic increase in demand was easily met. Gatev and Strahan (2003) show that funding supply to banks moves inversely with market liquidity—that is, when commercial paper spreads widen, banks face a greater *supply* of funds (especially transactions deposits). Thus, when

2. Liquidity risk has been used to justify government deposit insurance (e.g., Diamond and Dybvig, 1983).

3. In a Modigliani-Miller world, holding cash is not costly. However, in a world with taxes, financial distress, or agency costs, holding cash or other liquid assets is costly for banks and other firms (e.g., 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. Commercial paper often has maturity as short as one week. Firms, however, routinely roll over their paper as it matures.

liquidity demands are at their highest, so is funding supply. Gatev and Strahan argued that banks can weather a liquidity storm due to their perceived status as a safe haven for funds.

In this paper, we study the 1998 crisis to investigate differences *across* banks in their ability to manage systematic liquidity risk. We show that during the 1998 crisis, loan commitments exposed banks to liquidity risk, whereas transactions deposits insulated them from this risk. First, we report evidence from the equity market that transactions deposits reduce bank risk exposure, whereas unused loan commitments increase their exposure. We measure risk using stock return volatility observed during the three-month period beginning in the middle of August, when the crisis began with the announcement of the Russian default. During this period, bank stock prices were buffeted by news of the Russian crisis, followed by the demise of the hedge fund LTCM in late September, and finally by the drying up of the commercial paper market in the first week of October. Banks with more unused loan commitments had higher risk, whereas those with more transactions deposits had lower risk. We compare this pattern with the three months prior to the Russian default, and show a much smaller correlation between risk and loan commitments or risk and transactions deposits.

Second, we extend the Kashyap, Rajan, and Stein (2002) and Gatev and Strahan (2003) results by exploring in greater detail how bank deposit growth responded to the 1998 liquidity crisis. We argue that the synergy between deposits and loan commitments emphasized by Kashyap, Rajan, and Stein—that banks can reduce risk through diversification by holding demand deposits and loan commitments—becomes especially powerful during crises, because investors tend to move funds from the capital markets into their bank during these times. The conditional correlation between liquidity demanded from depositors and liquidity demanded by borrowers becomes *negative* during crises, thereby dramatically increasing the diversification benefit of combining these two products. This negative correlation shows up as an increase in funds flowing into bank transaction deposit accounts at the same time that funds are flowing out of the bank as borrowers take down funds from preexisting lines of credit.

As evidence, we test how funding behaved during the first weeks of October 1998, when banks faced a dramatic increase in demand for funds from firms unable to roll over their commercial paper. This increase in liquidity demand obligated banks to supply funds because firms had established their commercial paper backup lines prior to the onset of the crisis. We find that banks with more transactions deposits as a share of total deposits (based on data just *before* the onset of the crisis) had much greater inflows of deposits, and that all of those inflows were concentrated among transactions deposits rather than other deposits. Banks with more unused

loan commitments before the onset of the crisis also experienced increased growth of deposits, which reflected their greater demand for funds (resulting from takedown demand by their borrowers). We find that these relationships reversed sign at the end of October, as the commercial paper spreads fell and the market began to function as it normally does—that is, as the crisis subsided funds flowed out of bank transactions deposit accounts and, presumably, back into the capital markets.

Our results show that transactions deposits play a critically important role in allowing banks to manage their liquidity risk. The findings strengthen the Kashyap, Rajan, and Stein theoretical argument, and they can help explain the robust positive correlation across banks between transaction deposits and loan commitments.

The remainder of the paper proceeds as follows. Section 3.2 following, provides some background by describing banks' liquidity insurance role in the commercial paper market, and describes the chronology of the 1998 crisis. The key issue for our test is finding the right week(s) when banks faced a systematic increase in liquidity demand. Section 3.3 then describes our data, empirical methods, and results. Section 3.4 concludes the paper.

3.2 The 1998 Liquidity Crisis

The focus of this paper is how the banking system in the United States survived the dramatic decline in risky asset prices during the fall of 1998. The episode has been called a liquidity crisis mainly because the widespread decline in asset prices did not seem to be fully explainable based on cash-flow fundamentals. But for our purposes, these events did lead to a well-defined liquidity crisis in the commercial paper market, because a large number of borrowers were unable to refinance their paper as it matured. In response, many of these issuers turned to their bank for funds.

In our first set of results, we focus on bank stock return volatility during the whole three-month period, beginning when Russia defaulted (August 17) and ending after spreads in the commercial paper market returned to normal levels (November 17). As shown in Kho, Lee, and Stulz (2000), bank stock prices were hit throughout this period by news about conditions in credit markets around the world. We do not model changes in the level of stock prices, which would require us to pinpoint exactly which events were viewed as harmful (e.g., Russia's default and subsequent deviation) or helpful (e.g., announcements that the International Monetary Fund [IMF] would intervene in Brazil). Instead, we focus on explaining how the cross-section of stock return volatility, measured throughout the whole three-month period, reflects exposure to liquidity risk as well as a bank's ability to manage that risk.

We then analyze the cross-section of deposit changes, focusing specifi-

cally on the one-week period ending on October 5. While the whole three-month period following the Russian default did raise uncertainty for banks and bank stock prices (fig. 3.1), it was *only* during October that banks in fact faced a sharp increase in liquidity demands. Thus, while forward-looking stock prices (and hence volatility) over the whole period reflected the effects of the liquidity crisis, bank balance sheets only reacted during the weeks when liquidity demand spiked.

Bad news began on August 17, 1998, when the Russian government announced its intention to default on its sovereign debt, floated the exchange rate, and devalued the ruble (Chiodo and Owyang 2002). The announcement was followed by a steep drop in U.S. equity prices during the last two weeks of August, and a sustained period of high volatility in asset markets around the world (fig. 3.1).

Outside of the U.S. equity market, the prices of risky debt securities across the whole credit spectrum and across markets began to fall sharply after Russia's announcement. As an example, the spread between speculative grade and investment grade debt in the U.S. bond market rose from about 1.8 percentage points in mid-August to 2.5 percentage points by October. Spreads of risky bonds outside the United States, as well as swap spreads, also widened dramatically (Saidenberg and Strahan, 1999).

Partly as a result of the simultaneous collapse in the prices of risky assets across many markets, the hedge fund LTCM announced to its shareholders on September 2 that the fund had sustained large losses. These losses mounted as credit spreads continued to widen, moving well beyond levels that had been observed during the 1990s. LTCM was unable to secure additional investment from its owners or liquidity support from its creditors (Lowenstein, 2000). As a result, the hedge fund faced the possibility of an uncoordinated unwinding of its large positions in the bond and swaps markets. The Federal Reserve Bank of New York, fearing the potential systemic consequences of a rapid liquidation of LTCM's large positions in the face of already falling asset prices, brokered a private-sector restructuring of the fund. The news of the restructuring became public on Wednesday, September 23.[5]

The effects of these events can be seen clearly in tracking bank stock prices over this period. Panel A of figure 3.1 reports the change in an equally weighted index of bank stock prices and the Standard and Poor's (S&P) 500 from the middle of May 1998 through the middle of November. Panel B reports the conditional volatility over the same period for this bank-stock index.[6] Bank stock prices began to fall in the summer and then

5. See Edwards (1999) for an evaluation of the policy implications of the Fed's actions.

6. The conditional volatility (standard deviation) is estimated from an exponential generalized autoregressive EGARCH (1,1) model with a first-order auto-regressive process for the mean (Nelson, 1991).

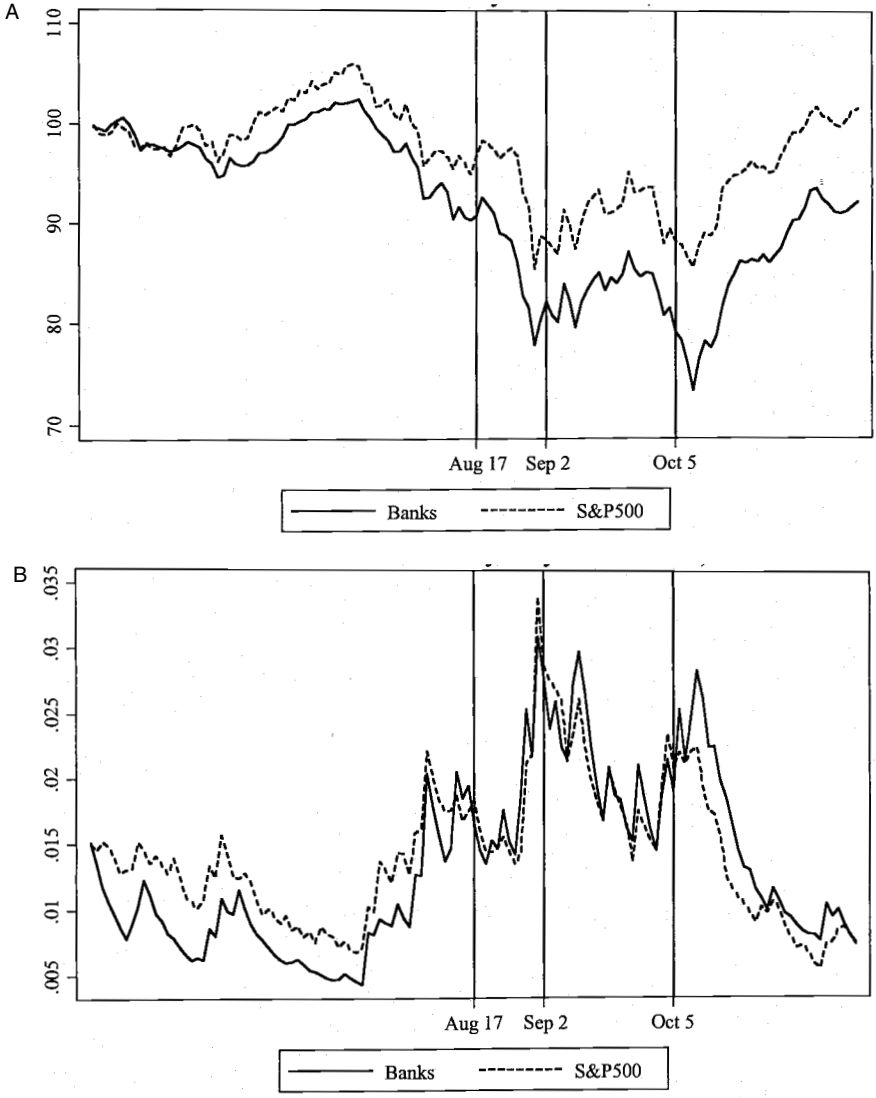

Fig. 3.1 Bank performance from May 14 to November 17, 1988: *A,* Stock-price index; *B,* Conditional stock-return volatility

dropped sharply after the Russian default on August 17. Prices stabilized in September until the announcement of the restructuring of LTCM and the pull-back in the commercial paper market, then fell sharply again. The conditional volatility of bank stocks also spiked just after the Russian default, stabilized in September, and spiked again in the beginning of October. Both the level and volatility of bank stock prices quickly recovered in

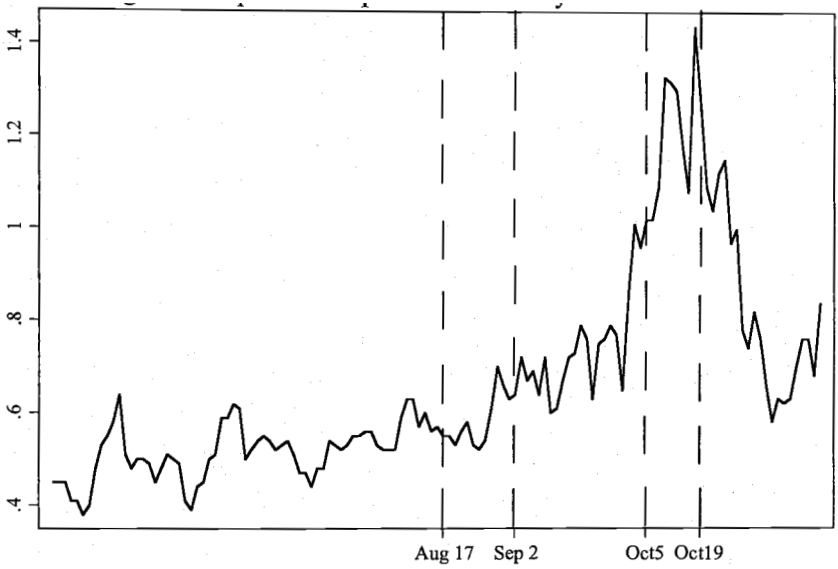

Fig. 3.2 Paper-bill spread in BPS May 14–November 17 1998

the second half of October. While these patterns are also evident for the S&P 500, the effects of the 1998 crisis appear larger for banks' stocks, both in terms of price levels and return volatility.[7]

The U.S. commercial paper (CP) market also began to feel the effects of investors' pulling back from risky assets during the week following LTCM's collapse. Spreads on short-term, high-grade CP over Treasury securities of comparable maturity had risen gradually throughout the end of August and through September, from about 55 basis points to about 70 basis points just prior to LTCM's demise. Spreads then jumped sharply, rising to more than 100 basis points and remaining at that level for the first three weeks of October (fig. 3.2). Spreads on low-grade commercial paper increased even more than spreads on high-grade paper. The jump in these spreads reflected rationing in the commercial paper market, as the stock of outstanding commercial paper declined by more than 2 percent during the month of October.[8] Credit rationing places issuers in the position of facing a liquidity crisis as their paper comes due.[9] Chava and Purnanadam

7. Note that bank stock volatility was lower than the S&P 500 before the crisis, but equal to or larger during the crisis.

8. Stiglitz and Weiss (1981) show that equilibrium credit rationing is possible when borrowers are better informed than lenders.

9. Such crises had happened before 1998. Banks' role in offering liquidity insurance originated early in the development of the commercial paper market when the Penn Central Transportation Company defaulted on more than $80 million in commercial paper outstanding. As a result of this default, investors lost confidence in *other* large commercial paper issuers, mak-

(2005) provide evidence that the CP market ceased to function at the beginning of October, by comparing abnormal returns for firms with and without access to this market. They show first that stock prices of CP issuers fell much less than other firms in response to the decline in bank financial condition during September of 1998 (while markets continued to function). During the first two weeks of October, however, the stock prices of *all* firms, regardless of their ability to access the CP market, fell equally. Thus, *all* firms became bank dependent—even CP issuers—during these weeks (because markets ceased to function).

At the same time that the CP market was drying up, growth in bank lending accelerated dramatically, because the commercial paper issuers began to draw funds from their backup lines of credit. This growth in lending was concentrated at banks with high levels of undrawn loan commitments prior to the onset of the crisis. For example, among the top fifty banks, those with above-average levels of undrawn loan commitments (scaled by total loans plus commitments) saw lending rise three times as fast as banks with below-average undrawn loan commitments (Saidenberg and Strahan 1999). Moreover, press reports suggest that most of the bank loan growth during the beginning of October occurred because of strong takedown demand by commercial paper issuers drawing funds from preexisting credit lines rather than because of new loan originations. The *New York Times* reported, for example, that "rather than signaling a flow of new loans, much of the lending appears to be borrowers' drawing on existing lines of credit" (Uchitelle 1998). Thus, the liquidity crisis moved seamlessly from CP issuers to their banks. As we show next, banks with larger transaction deposits were better positioned to face this crisis: they experienced less volatility in their stock prices and, when the liquidity demands hit hardest, they experienced the greatest inflows of funds.

Expressing concern that "growing caution by lenders and unsettled conditions in financial markets more generally [were] likely to be restraining aggregate demand in the future," the Federal Reserve decreased the target Fed Funds rate by 25 basis points on September 29 and again on October 15, 1998.[10] The rate was dropped another 25 basis points on November 17. It did not stay low for long, however, going back up to 5 percent in two steps by November 1999.

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ing 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, commercial paper issuers thereafter began purchasing backup lines of credit from banks to insure against future funding disruptions.

10. The announcement can be found at http://www.federalreserve.gov/boarddocs/press/monetary/1998.

3.3 Empirical Methods, Data, and Results

In this section, we report our results linking stock return volatility and changes in bank deposits to bank characteristics during the 1998 crisis. We first describe our empirical methods, then our data, and last we report the results.

3.3.1 Empirical Methods

We test how preexisting open lines of credit and preexisting levels of transactions deposits affect both risk (stock returns) and deposit flows. Unused loan commitments expose banks to liquidity risk. Thus, we expect banks with more open credit lines to face greater liquidity risk (higher stock return volatility) and to face a greater demand for loans when the commercial paper market dried up in the beginning of October 1998 (faster deposit growth). Kashyap, Rajan, and Stein argue that *combining* loan commitments with transactions deposits lowers risk due to diversification (because demands are less-than-perfectly correlated). This force is especially powerful during liquidity crises like the autumn of 1998, because uninformed investors put funds into banks as a safe haven for their wealth. Thus, banks with more transactions deposits ought to have had lower risk than other banks. And when the CP market dried up, such banks ought to have experienced faster growth of deposits, as funds flowed into their transactions accounts from investors that would normally buy commercial paper.

To be more precise, we estimate two sets of cross-sectional regressions with the following structure:

$$\begin{aligned}(1)\qquad \text{Stock Return Volatility}_i = {} & \alpha_1 + \gamma_1 \text{Loan Commitment Ratio}_i \\ & + \gamma_2 \text{Transaction Deposit Ratio}_i \\ & + \text{Control Variables}_i + \varepsilon_{1,i}\end{aligned}$$

$$\begin{aligned}(2)\qquad \text{Deposit Change}_i = {} & \alpha_2 + \beta_1 \text{Loan Commitment Ratio}_i \\ & + \beta_2 \text{Transaction Deposit Ratio}_i \\ & + \text{Control Variables}_i + \varepsilon_{2,i},\end{aligned}$$

where *i* refers to the bank. We estimate each of these regressions during the crisis period and during a noncrisis period. For the crisis period, we expect the following: $\gamma_1 > 0$ and $\gamma_2 < 0$; $\beta_1 > 0$ and $\beta_2 > 0$. For equation (1), we estimate a noncrisis period that ends in the middle of August; we expect similar qualitative results but much smaller magnitudes. For equation (2), we estimate the relationships during the weeks when the CP market dried up (crisis weeks), and again during the weeks when this market recovered.

In this case, we would expect opposite relationships during the noncrisis period. Funds should flow into banks as the CP market dries up, and back out as it rebounds.

3.3.2 Data

Explanatory Variables

To construct measures of liquidity risk exposure and transactions deposits we follow the procedures outlined by Kashyap, Rajan, and Stein (2002). We use the level of unused loan commitments as of June 1998 (that is, before the onset of the crisis), scaled by the sum of unused loan commitments plus total on–balance sheet loans.[11] This variable is our measure of a bank's potential exposure to a liquidity shock.[12] In our deposit flow regressions, the unused commitments ratio can be thought of as a proxy for the high level of demand for funds that a bank may need to meet from CP issuers unable to roll over their paper.

To measure the size of a bank's transactions deposit base, we use total transactions deposits divided by total deposits. We take this variable from the Federal Reserve's FR2900 (Report of Transaction Accounts, Other Deposits, and Vault Cash) as of August 10, 1998, the last date prior to the onset of the crisis. The FR2900 provides confidential and detailed weekly data on bank deposits used to measure levels and changes in the money supply.[13] Some of the deposit components are also used to calculate reserve requirements. Using a separate data source, Kashyap, Rajan, and Stein show that transaction deposits are highly correlated with the loan commitment variable across banks, regardless of bank size. (Note that we also find a very strong positive correlation between transactions deposits and loan commitments in our data.) They do not, however, test whether transactions deposits in fact help banks hedge against the risks of a liquidity shock. That is, they do not measure the correlation of liquidity demands across these two classes of customers. This is where our approach extends and sharpens their empirical findings.

Our sample includes all domestic banking organizations with assets over $1 billion (as of the June 1998 Call Report). We exclude the smaller banks because most of the commercial paper backup lines of credit are issued by large banks, and, as we have said, the liquidity shock was driven by the absence of liquidity in the commercial paper market. Again following

11. We alter this definition slightly relative to what Kashyap, Rajan, and Stein use by taking out unused loan commitments to retail customers (i.e., credit card lines). These retail exposures did not create liquidity problems for banks in the fall of 1998.

12. Unfortunately, we know of no data that would allow us to observe the amount of funds actually taken down off of preexisting lines of credit, which would be the best ex post measure of the shock to loan demand.

13. The confidential data were processed solely within the Federal Reserve for the analysis presented in this paper.

Kashyap, Rajan, and Stein, we aggregate the bank-level data from the June 1998 Call Report up to the level of the highest holding corporation. This aggregation takes account of the possibility that affiliated banks can pool their resources to hedge against unexpected liquidity shocks.

Beyond the two variables of interest, we also control for a series of additional bank characteristics, including the log of total assets, the capital-asset ratio, an indicator equal to 1 for banks with a credit rating, the ratio of liquid assets (cash plus securities) to total assets, the ratio of Fed Funds purchased to total assets, and an indicator equal to 1 if the bank's stock is publicly traded. We include bank size and capital to test whether risk or deposit inflows are affected by insolvency risk—larger and better-capitalized banks are less likely to fail, all else being equal. Larger banks may also have been viewed as safer than smaller ones if the implicit government safety net is more readily available to them. We control for asset liquidity for the obvious reason that banks with more liquid balance sheets will be better able to meet the demands of borrowers taking down funds from preexisting loan commitments. Similarly, banks with greater access to the Fed Funds market may be better able to weather a liquidity shock. The publicly traded and rated indicators are included to test whether less opaque banks fared better during the crisis. Last, we include indicator variables equal to 1 for banks exposed to Russia and to LTCM (see Kho, Lee, and Stulz, 2000).

Dependent Variables

To measure bank risk, we use three months of daily stock return data from the Center for Research in Security Prices (CRSP) to construct the standard deviation of each bank's stock return from the onset of the crisis on August 17, 1998. We construct the same volatility measure during the three-month period *ending* on August 14 to obtain a benchmark set of results to make sure that the relationships we observe during the fall really have something to do with the liquidity crisis, rather than some time-invariant characteristics of banks.

For deposit flows, we construct the change in total deposits during the week ending on October 5, 1998. This first week of October follows the restructuring of LTCM at the end of September, and was the critical week in which CP spreads first spiked (fig. 3.2). Spreads remained high for an additional two weeks, so we also report as a robustness test the change in deposits during the three-week period ending on October 19.

For each of our deposit change results, we also report a parallel set of regressions for the week ending on October 26 (the week the spreads began to subside), and the three-week period ending on November 6, 1998. These weeks represent a resumption of normal conditions in the commercial paper market. Spreads began to fall after October 16, from a high of 150 basis points to below 100 basis points by October 26, and then fell below 60 basis points by November 4. We also split the change in total deposits into

the change in transactions deposits and the change in all other deposits to test whether these two kinds of products responded differently when liquidity demanded by the commercial paper issuers peaked.[14] Each of these changes is normalized by the bank's total assets as of June 1998.[15] As with the level of preexisting transactions deposits, the data for deposit changes come from the Federal Reserve's FR2900 data.

3.3.3 Results

Summary Statistics

Table 3.1 reports summary statistics for our dependent variables (panel A) and for our explanatory variables (panel B). Bank stocks clearly became significantly more volatile during the fall of 1998, rising from a daily standard deviation of 2.0 percent for the average bank before the crisis to 3.4 percent during the crisis.[16] Moreover, the bank deposit change variable was much higher during the crisis weeks at the beginning of October than during the weeks at the end of the month. For example, the change in deposits relative to assets averaged 1.4 percent during the first week of October (crisis period), whereas deposits actually shrank by 0.4 percent of assets during the week ending on October 26 (noncrisis period). Deposit change during that first week of October annualizes to a change of about *70 percent* of assets.

As noted, we take most of our explanatory variables from the June 1998 Call Report, to be sure that they are predetermined with respect to the onset of crisis, with one exception: the transactions deposit ratio is taken from the August 10, 1998, FR2900 data, both to ensure comparability with the deposit changes, and because we wanted to measure a bank's transaction deposit franchise as close to the onset of the crisis as possible.

As reported in table 3.1, a typical bank held unused loan commitments equal to about 19 percent of its total credit exposure (on–balance sheet loans plus unused commitments). The transactions deposit variable averaged 0.189, and exhibited a wide range (from zero to 0.49). These are the two explanatory variables of greatest interest, because they allow us to test

14. Transaction accounts is the sum of demand deposits, Automatic Transfer Service (ATS) accounts, NOW accounts/share drafts and telephone pre-authorized transfers.

15. We considered looking at deposit growth, but this variable displays some large outliers, especially when we disaggregate the deposits (e.g., transaction versus nontransaction deposits, and demand versus other transaction deposits). Normalizing the change in deposits by total assets reduces the outlier problems, but we also trim the deposit changes at the 1st and 99th percentiles in the regressions reported in this paper. The results do not change materially for the crisis weeks if we do not trim, but the coefficient on deposit changes during the noncrisis period becomes much larger (as does its standard error) due to the influence of one observation.

16. These volatility figures are higher than the conditional volatilities plotted in figure 3.1 because they include bank-specific idiosyncratic risk. The data in figure 3.1 are based on an equally weighted index of bank stocks.

Table 3.1 **Summary statistics**

	Crisis period		Noncrisis period	
	Mean (1)	Standard deviation (2)	Mean (3)	Standard deviation (4)
A. Dependent variables				
Stock return volatility	0.034	0.011	0.020	0.006
Change in total deposits/assets$_{6/98}$	0.014	0.011	–0.004	0.013
Change in transactions deposits/assets$_{6/98}$	0.004	0.009	–0.002	0.008
Change in nontransaction deposits/assets$_{6/98}$	0.011	0.015	–0.003	0.012
B. Explanatory variables				
Transactions deposits/total deposits	0.189	0.100		
Unused commitments/(Commitments + Loans)	0.187	0.127		
Log of assets	15.23	1.38		
Russia exposure indicator	0.022			
LTCM exposure indicator	0.013			
Capital/Assets	0.092	0.039		
Fed funds purchased/assets	0.068	0.066		
(Cash + Securities)/assets	0.324	0.141		
Has a credit rating indicator	0.349			
Is publicly traded indicator	0.838			

Notes: Dependent variables: Stock return volatility equals the standard deviation of daily stock returns. The change in deposits is taken from the Federal Reserve's FR2900 data.

Explanatory variables: With the exception of the transactions deposit ratio, explanatory variables are taken from the June 1998 Call Report. The transactions deposit/total deposits ratio is taken from the August 10, 1998, FR2900 data, as are the deposit change rates (the dependent variables).

Crisis/Noncrisis periods: For stock return volatility, the crisis period begins on August 17, 1998, (when Russia defaulted) and ends three months later. The noncrisis period is the three-month period ending on August 14, 1998. For deposit change, the crisis week is the week ending on October 5, 1998 (the week that commercial paper spreads began to subside).

the Kashyap, Rajan, and Stein model, which implies that exposure to takedown risk on loan commitments can be partly hedged with transactions deposits. Means for the other controls variables are also reported in table 3.1. Average bank size in the sample was $16.5 billion (log of assets averaged 15.23). Two percent of the banks in the sample had exposure to Russia, and a little more than 1 percent (four banks) of the banks had exposure to LTCM. Most of the banks are publicly traded (84 percent), but fewer than half have a credit rating (35 percent).

Bank Stock Return Volatility

Table 3.2 reports the regression estimates for equation (1), where bank stock return volatility is the dependent variable. During the crisis period, there is a positive association between the unused loan commitments and volatility (although not statistically significant at conventional levels), and a significant negative association between the size of a bank's transactions deposit ratio and volatility. That is, loan commitments seem to have *ex-*

Table 3.2 Bank liquidity risk declines with size of bank's transactions deposit franchise

	Dependent variables	
Explanatory variables	Crisis period stock return volatility: 8/17/98–11/17/98 (1)	Noncrisis stock return volatility: 5/14/98–8/14/98 (2)
Transactions deposits/Total deposits	–0.037**	–0.008*
	(0.011)	(0.004)
Unused commitments/(Commitments + Loans)	0.010	0.001
	(0.011)	(0.004)
Log of assets	0.001	–0.001
	(0.001)	(0.001)
Russia exposure indicator	0.003	0.001
	(0.004)	(0.001)
LTCM exposure indicator	0.017**	0.011
	(0.006)	(0.006)
Capital/Assets	0.039**	0.003
	(0.014)	(0.007)
Fed funds purchased/Assets	–0.001	0.010
	(0.010)	(0.006)
(Cash + Securities)/Assets	0.002	–0.004
	(0.007)	(0.004)
Has a credit rating indicator	–0.001	–0.002
	(0.002)	(0.001)
N	175	178
R^2	0.18	0.12

Notes: All regressions include an intercept, which is not reported. Coefficients reported with robust standard errors in parentheses. With the exception of the deposit ratio, explanatory variables are from the June 1998 Call Report. The transactions deposit/total deposits ratio is taken from the August 10, 1998, FR2900 data.

**Indicates statistical significance at the 5 percent level.

*Indicates statistical significance at the 10 percent level.

posed banks to risk (weakly), while transactions deposits helped them *hedge* that risk. The coefficient on the transaction deposits variable is especially striking. For example, a 1 standard deviation increase in this variable came with a decrease in stock return volatility of 0.004, which is about 40 percent of the cross-sectional standard deviation in stock return volatility. During the 1998 crisis a bank with a large transaction deposit base experienced much lower stock return volatility because, as we will show, it received a large inflow of new deposits. This result highlights how banking has changed in recent years. Before the introduction of government safety nets, transactions deposits could sometimes expose a bank to liquidity risk when consumers simultaneously removed deposits to increase consumption. This bank-run problem has traditionally been viewed as the primary source of bank liquidity risk and lies behind bank reserve requirements for

demand deposits. Rather than open banks to liquidity risk, however, deposits now seem to insulate them from that risk.

Table 3.2 also shows that the relationships observed during the 1998 crisis *do not* reflect the normal links from liquidity exposure to risk. The coefficients on both loan commitments and transactions deposits in the volatility regressions are much smaller during the noncrisis period, and this difference is statistically significant at the 5 percent level.[17] The effect of transactions deposits falls by a factor of about five, and the effect of loan commitments falls by a factor of ten. Thus, the extent to which combining loan commitments with transactions deposits helps banks hedge risk was *dramatically larger during the 1998 liquidity crisis than during normal times.* This is consistent with our argument that the conditional correlation between liquidity demands of depositors and borrowers goes negative during liquidity crises—depositors put their money in banks just as borrowers draw money out. In other words, the diversification synergy of combining loan commitments and transactions deposits is especially powerful during crises.

Banks with LTCM exposure also had much higher stock return volatility than other banks during the crisis months. Sensibly, LTCM investments increased bank equity risk, both before and after the Russian default was announced. This result is consistent with Kho, Lee, and Stulz (2000), who show that LTCM-exposed banks experienced a relatively large decline in stock prices compared to other banks when the hedge fund's problems first became public, and again when the coordinated restructuring occurred.[18] Our results suggest that the market was aware of potential LTCM risk even before the news of the fund's difficulties became widely recognized (i.e., the coefficient is positive even during our precrisis period). This coefficient, of course, could be capturing more than just LTCM risk, to the extent that these banks were engaged in other risk-enhancing activities, such as proprietary trading.

Somewhat to our surprise we find no effect on volatility of bank size or the other measures of liquidity risk (the fed funds purchased-to-assets or liquid assets-to-total-assets ratios). We find that banks with more capital had higher, rather than lower, stock-return volatility. The small coefficient on bank size indicates that large banks were not viewed as relatively safer during the crisis, as might be expected if government safety nets become relatively more valuable for large banks at these times. These results are

17. In addition, we have estimated the volatility model for the crisis period, with the noncrisis volatility (i.e., the lagged dependent variable) included as a right-hand side variable. In these models, the fit (R^2) increases, but the magnitude and statistical significance of the other regressors remain similar to those reported in column 1 of table 3.2.

18. The LTCM-exposed banks became equity holders in LTCM after the restructuring. Note that despite the higher equity risk for these banks, they were probably not close to insolvency. Furfine (2002) shows that LTCM-exposed banks continued to have access to borrowing in the unsecured Fed Funds market during this period.

consistent with our subsequent deposit-flow evidence and with the findings of Gatev and Strahan (2003), who show that funds flowed into banks across the board rather than to large (or well-capitalized) banks.[19]

Bank Deposit Inflows

In tables 3.3–3.6, we report estimates of the links from banks' transactions deposits base and their total unused loan commitments to deposit inflows during the crisis and recovery weeks of the commercial paper market. Table 3.3 focuses first on total deposit flows. During the first week of October, banks with more transactions deposits (as of the beginning of the crisis) experienced *larger inflows of funds* than other banks (column [1]).[20] Moreover, these funds seemed to have flowed *out* of banks as the CP market recovered during the week ending October 26 (column [2]). Similarly, we find that banks with higher levels of preexisting unused or open loan commitments had greater inflows during the crisis week, and greater levels of outflows during the recovery week. Banks with high levels of open credit lines thus seem to have experienced the greatest takedown demand, as CP issuers turned to their banks for liquidity. This liquidity shock is reflected by deposits that were pulled into the bank by high loan demand. Banks with higher levels of transactions deposits, however, also experienced greater inflows. We interpret this latter inflow as a deposit-supply response to the crisis: when investors lost their nerve, two things happened. First, the CP market dried up. Second, funds normally invested in commercial paper flowed temporarily into bank accounts. Thus, banks with high levels of both open commitments and transactions accounts experienced *offsetting flows of funds.*[21]

Table 3.4 sharpens this result by looking at the flows into bank transaction deposit accounts and into nontransaction deposit accounts separately. During the crisis week, the positive correlation between preexisting transaction deposits and deposits flow shows up *only* in the transactions deposits accounts (panel A). That is, banks with a large base of transactions deposit accounts experienced flows of funds into those accounts. In contrast, there is a *negative* correlation between the size of a bank's trans-

19. Gatev and Strahan (2003) use call report data to analyze the effects of CP spreads and loan commitments on balance sheet changes at quarterly frequency. Hence, they are not able to focus specifically on how deposit growth behaved during the critical weeks in October when takedown demand by commercial paper issuers spiked.

20. We have also included an indicator variable for four large banks involved in wholesale payments processing to our model (Bank of New York, State Street Bank, Northern Trust, and Mellon Bank). These banks did not experience greater inflows than other banks.

21. We have also estimated our model for subsamples of above- and below-median size banks. In both samples, we find that deposit flows were greater for banks with more transactions deposits (significant for large banks) and more unused loan commitments (significant for smaller banks). The transactions deposit coefficient was slightly larger for the above-median banks, whereas the coefficient on preexisting unused loan commitments was slightly larger for the below-median banks.

Table 3.3 Deposits flow more into banks with larger transactions deposit franchise

	Dependent variables	
Explanatory variables	Crisis period change in deposits/Assets$_{6/98}$: 9/28/98–10/05/98 (1)	Noncrisis change in deposits/Assets$_{6/98}$: 10/19/98–10/26-98 (2)
Transactions deposits/Total deposits	0.020*	–0.024*
	(0.011)	(0.010)
Unused commitments/(Commitments + Loans)	0.022**	–0.016**
	(0.010)	(0.007)
Log of assets	–0.001	–0.002
	(0.001)	(0.001)
Russia exposure indicator	–0.010**	0.003
	(0.004)	(0.004)
LTCM exposure indicator	–0.005	0.009*
	(0.005)	(0.005)
Capital/Assets	–0.026	–0.006
	(0.016)	(0.014)
Fed funds purchased/Assets	–0.002	–0.007
	(0.011)	(0.010)
(Cash + Securities)/Assets	0.001	0.001
	(0.006)	(0.006)
Has a credit rating indicator	0.004	0.006
	(0.003)	(0.004)
Is publicly traded indicator	–0.002	0.001
	(0.002)	(0.002)
N	223	222
R^2	0.12	0.14

Notes: All regressions include an intercept, which is not reported. Coefficients reported with robust standard errors in parentheses. With the exception of the deposit ratio, explanatory variables are from the June 1998 Call Report. The transactions deposit/total deposits ratio is taken from the August 10, 1998, FR2900 data, as are the deposit change rates (the dependent variables). The change in deposits is trimmed at the 1st and 99th percentiles.

**Indicates statistical significance at the 5 percent level.

*Indicates statistical significance at the 10 percent level.

actions deposit base and flows into nontransaction deposits. Also, there is no correlation between unused loan commitments and flows into transactions deposits.

The results in table 3.4 validate our interpretation of unused loan commitments as controlling for shocks to loan *demand* (and hence bank demand for funds), whereas the size of the transactions deposit base controls for shocks to deposit *supply.* The deposit-supply response to shocks at high frequency affects the transactions accounts, but demand shocks do not (hence the lack of correlation between unused lines and flows into transactions accounts). Banks are not likely to be able to fund high-frequency

Table 3.4 **Deposits flow more into bank transactions-deposit accounts**

	Dependent variables	
Explanatory variables	Change in transactions deposits/Assets$_{6/98}$: 9/28/98–10/05/98 (1)	Change in nontransactions deposits/Assets$_{6/98}$: 9/28/98–10.05/98 (2)
A. Transactions versus Nontransactions deposit		
Transactions deposits/Total deposits	0.044**	–0.035**
	(0.009)	(0.016)
Unused commitments/(Commitments + Loans)	–0.009	0.038**
	(0.006)	(0.015)
Log of assets	0.001	–0.001
	(0.001)	(0.001)
Russia exposure indicator	–0.004	–0.007
	(0.003)	(0.004)
LTCM exposure indicator	0.001	–0.006
	(0.003)	(0.006)
Capital/Assets	0.009	–0.046*
	(0.016)	(0.027)
Fed funds purchased/Assets	0.009	–0.010
	(0.012)	(0.016)
(Cash + Securities)/Assets	–0.008	0.002
	(0.005)	(0.008)
Has a credit rating indicator	0.002	0.001
	(0.002)	(0.004)
Is publicly traded indicator	–0.003	0.002
	(0.001)	(0.002)
N	222	223
R^2	0.22	0.09

	Dependent variables	
	Change in demand deposits/Assets$_{6/98}$: 9/28/98–10/05/98 (3)	Change in other transactions deposits/Assets$_{6/98}$: 9/28/98–10/05/98 (4)
B. Demand deposits versus all other transactions deposit		
Transactions deposits/Total deposits	0.039**	0.004
	(0.007)	(0.004)
Unused commitments/(Commitments + Loans)	–0.005	–0.004
	(0.006)	(0.003)
Log of assets	0.001	0.001
	(0.001)	(0.001)
Russia exposure indicator	–0.004	–0.001
	(0.003)	(0.001)
LTCM exposure indicator	–0.001	0.001*
	(0.003)	(0.001)
Capital/Assets	0.003	0.006
	(0.012)	(0.007)

Table 3.4 (continued)

	Dependent variables	
	Change in demand deposits/Assets$_{6/98}$: 9/28/98–10/05/98 (3)	Change in other transactions deposits/Assets$_{6/98}$: 9/28/98–10/05/98 (4)
Fed funds purchased/Assets	0.005	0.005
	(0.010)	(0.005)
(Cash + Securities)/Assets	–0.004	–0.003
	(0.004)	(0.003)
Has a credit rating indicator	0.002	0.001
	(0.001)	(0.001)
Is publicly traded indicator	–0.002*	–0.001
	(0.001)	(0.001)
N	222	222
R^2	0.24	0.03

Notes: See table 3.3.

**Indicates statistical significance at the 5 percent level.

*Indicates statistical significance at the 10 percent level.

demand shocks with transaction deposits unless they experience inflows into preexisting accounts. Banks without such supplies of funds need to resort to other sources when takedowns increase unexpectedly. Hence, in column (2) of table 3.4 we estimate a positive and significant effect of unused loan commitments and change in nontransactions deposits. Moreover, the negative coefficient on the transaction deposits/total deposits variable also makes sense, because banks with more transactions account ex ante experienced large increases in funding supply into these accounts (column [1]); hence, their demand to raise nontransactions deposits was lower (column [2]).

Next, we test whether banks are paying higher interest rates for the funds that flow into their transactions accounts. In table 3.4, panel B, we disaggregate the transactions deposit change into the change-in-demand deposits versus the change in all other transaction accounts. These other accounts include such interest-bearing accounts as negotiable order of withdrawal (NOW) accounts. Because banks pay no interest on demand deposit accounts, we can be sure that the flows into these accounts do *not* reflect an increase in a bank's willingness to pay for funds. That is, any change in these accounts (especially at high frequency, such as one week) must reflect shifts in *deposit supply* rather than shifts in the bank's demand for funds. In fact, we find that all of the increased funding flows are concentrated in demand deposit accounts rather than other kinds of transactions deposit accounts.

Table 3.5 **Deposits flow more into banks with larger transactions deposit franchise (three week changes)**

	Dependent variables	
Explanatory variables	Crisis period change in deposits/Assets$_{6/98}$: 9/28/98–10/19/98 (1)	Noncrisis change in deposits/Assets$_{6/98}$: 10/19/98–11/09/98 (2)
Transactions deposits/Total deposits	0.036**	0.058
	(0.015)	(0.052)
Unused commitments/(Commitments + Loans)	0.006	–0.012
	(0.010)	(0.016)
Log of assets	–0.001	–0.005*
	(0.001)	(0.003)
Russia exposure indicator	0.063	–0.010
	(0.048)	(0.017)
LTCM exposure indicator	–0.067	0.019
	(0.048)	(0.017)
Capital/Assets	0.014	–0.025
	(0.041)	(0.097)
Fed funds purchased/Assets	0.029	–0.040
	(0.019)	(0.030)
(Cash + Securities)/Assets	–0.016*	–0.009
	(0.010)	(0.017)
Has a credit rating indicator	0.002	0.011
	(0.004)	(0.008)
Is publicly traded indicator	–0.001	–0.006
	(0.003)	(0.005)
N	223	222
R^2	0.17	0.07

Notes: See table 3.3.

**Indicates statistical significance at the 5 percent level.

*Indicates statistical significance at the 10 percent level.

Tables 3.5 and 3.6 report the same tests as tables 3.3 and 3.4, but now we expand the length of the crisis and noncrisis periods from one week to three weeks. We consider this test less powerful because the most dramatic changes in the CP market occurred rapidly. Nevertheless, we again find a positive correlation between banks' transaction deposit base and subsequent flows of deposit funds during the crisis weeks. As the crisis subsided at the end of October, the regression coefficient remained positive but lost statistical significance. That is, there is no statistically significant relationship between deposit flows and a bank's transaction deposit base as the commercial paper market recovered. (This result contrasts with the sign reversals observed at one-week frequency in table 3.4.) Table 3.6 again shows that the funding inflows related to a banks preexisting level of transactions deposits occurred into transactions accounts rather than non-

Table 3.6 **Deposits flow more into banks with larger transactions deposit franchise (three-week changes; transactions versus nontransactions deposits)**

	Dependent variables	
Explanatory variables	Change in transactions deposits/Assets$_{6/98}$: 9/28/98–10/19/98 (1)	Change in nontransactions deposits/Assets$_{6/98}$: 9/28/98–10/19/98 (2)
Transactions deposits/Total deposits	0.055**	–0.012
	(0.016)	(0.027)
Unused commitments/(Commitments + Loans)	–0.020	0.033
	(0.010)	(0.022)
Log of assets	0.001	–0.001
	(0.001)	(0.001)
Russia exposure indicator	0.013	0.049
	(0.008)	(0.041)
LTCM exposure indicator	–0.012	–0.057
	(0.009)	(0.041)
Capital/Assets	0.019	–0.033
	(0.020)	(0.052)
Fed funds purchased/Assets	0.010	–0.003
	(0.014)	(0.029)
(Cash + Securities)/Assets	–0.015**	0.013
	(0.007)	(0.016)
Has a credit rating indicator	–0.001	–0.002
	(0.001)	(0.005)
Is publicly traded indicator	–0.003	0.004
	(0.002)	(0.003)
N	222	223
R^2	0.18	0.08

Notes: See table 3.3.

**Indicates statistical significance at the 5 percent level.

transactions accounts.[22] Overall, the results based on the three-week changes point in the same direction as the one-week changes, but the differences between the crisis and noncrisis periods are somewhat muted.

3.4 Conclusions

This paper tests how bank equity risk and the supply of deposit funds reacted to the liquidity crisis of 1998. During this period, bank stock price

22. We also find some evidence of a negative correlation between balance-sheet liquidity and flows into bank transactions accounts during the three-week crisis window. It is hard to explain why bank liquidity would be negatively related to the supply of funds, and since this result is not robust to our choice of the crisis period, we are hesitant to draw strong conclusions from it.

volatility increased sharply in response to global shocks to credit markets. These shocks, which began when Russia defaulted, led to declining asset prices and widening spreads on risky debt across many markets in response to an investor "flight to quality." Spreads on safe securities, such as U.S. government securities, therefore fell sharply, while the supply of funds to banks increased. We show that this increase in funding supply was greatest at banks with large preexisting transactions deposit accounts. This seems sensible to the extent that investors expected the market uncertainty to be relatively short in duration. We also show that banks with greater transactions deposit accounts had much lower stock return volatility than other banks.

Our results extend and deepen our understanding of the deposit-lending synergy suggested by Kashyap, Rajan, and Stein (2002). According to their model, banks will combine liquidity provision to both depositors (through transactions deposits) and borrowers (through unused loan commitments) to reduce risk as long as liquidity demands from these two classes of customers are not highly correlated. The motivation for this combination is to diversify away some liquidity risk and thus reduce the need to hold cash. Our results suggest that this diversification effect becomes especially powerful during periods of crisis, when the correlation in demand for liquidity by depositors and by borrowers becomes *negative.* Depositors become net suppliers of liquidity during crises because they view banks as a safe haven, just as borrower demands for liquidity are at their highest. We find little relation between observable measures of bank safety, such as size, rating, or deposit flows. Thus, investors seem to view *all* banks as equally safe during liquidity crises (or at least during the 1998 crisis), presumably because of the presence of government safety nets and backup liquidity from the central bank.

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Comment Mark Carey

Gatev, Schuermann, and Strahan's paper is first-class research that persuasively argues that large commercial banks are uniquely positioned to act as a stabilizing force during systemic liquidity crises. They present compelling evidence that a large volume of funds flowed into demand deposit accounts at U.S. banks at the same time that corporations were drawing large amounts on their lines of credit, and that the volatility of bank stock prices was smaller for banks with a larger share of transaction deposits among their liabilities. The evidence is from the period around what is arguably the largest pure liquidity crisis of recent years, the Russian default

This discussion represents my own opinions, which are not necessarily those of the Board of Governors, other members of its staff, or the Federal Reserve System.

and subsequent collapse of Long-term Capital Management (LCTM) during 1998. The authors interpret their results as further evidence of a special role for banks that only recently has begun to receive more attention in papers such as Gatev and Strahan (2003) and Kashyap, Rajan, and Stein (2002). In this view, banks are special because they buffer idiosyncratic and systematic liquidity shocks, both for individual borrowers and depositors and for the financial system as a whole. Banks are able to do so because both demand for and supply of liquid funds shift in tandem such that individual banks are able to manage the net liquidity risk at relatively low cost.

I have no suggestions for improvements to this excellent paper. Instead, in the remainder of this discussion, I offer observations that amount to suggestions for future research.

One surprise in the empirical results is that very large banks were not more likely than medium-size banks to experience large flows during the crisis period. It is my impression that "money center" banks disproportionately serve financial market participants who might have been among those engaged in a flight to quality, and that they also meet the borrowing needs of the large corporations that were unable to roll over commercial paper (or were unwilling to do so, given that commercial paper [CP] market spreads were higher than the spreads specified in their backup lines of credit). Even though they are not among the largest banks, some "processing" banks, like State Street or Bank of New York, might experience large deposit inflows from entities for which they process financial transactions and might balance the liquidity risk by participating in the syndicates that typically provide large backup lines of credit. Such banks might introduce enough noise into the relationship between size and flows to make it undetectable in a regression context. It is more difficult to believe that purely regional banks that serve mainly small and middle-market business customers and that rarely participate in syndicated loans would experience the same impact of a LTCM-style liquidity crisis on loan and deposit flows. One way to shed light on this issue would be to simply publish a table that ranks banks by the proportional size of the flows they experience, but I suspect that Gatev, Schuermann, and Strahan could not do this because of the confidential data they use. Another possibility would be to use loan syndication data to identify the exposure of each bank to drawdowns on commercial paper backup lines, using this information in specifications similar to Gatev, Schuermann, and Strahan's.

Regardless of the empirical method, a more detailed understanding of which economic agents are responsible for systemic *and* systematic deposit and loan flows is a key area for future research. We need to know more about which kinds of events will feature offsetting deposit and loan flows and which will be more one-sided. For example, what if the events of a crisis lowered rates and spreads on all short-term instruments, including commercial paper, while still causing a flight-to-quality on the part of investors

in other financial assets, like bonds or equities? Flows of bank liabilities and assets might not be offsetting in such a case. Similarly, loss of confidence in one or more major banks almost surely would lead to withdrawals of deposits, but might not lead to paydowns of existing loan balances. Case studies of different kinds of events and panel-data studies are likely to be helpful, and I hope that these and other authors will produce such studies in the future.

Similarly, systematic relationships between deposit and loan flows might differ across nations and institutional structures. The U.S. institutional structure might be particularly supportive of the behavior revealed in Gatev, Schuermann, and Strahan's paper because commercial paper plays an important role and because, at least at the time, the details of CP backup lines of credit locked banks into lending at what turned out to be below-market spreads. In an environment where banks have more discretion about making advances and about the rates charged, it is possible that corporations facing rationing in one capital market might find it more difficult or costly to replace the lost funds. And in an environment where firms depend on banks for almost all debt finance, rapid flows of deposits into banks might not be offset by additional lending. This might happen, for example, if individuals in a nation of bank-dependent firms were placing significant amounts of savings in foreign vehicles, such as foreign bonds or mutual funds, and then the individuals lost confidence in the foreign vehicles.

I was also surprised at the authors' finding that bank equity volatility was negatively related to the share of total deposits in transaction deposits, but was not significantly positively related to the share of unused loan commitments in total loans and commitments. I can easily imagine a positive relationship between unused commitments and volatility: during the crisis, equity investors might reasonably fear that events would lead to a recession and that unused commitments might turn into loans to firms that eventually default, reducing bank earnings down the road.

It is harder to imagine why the relationship between volatility and transaction deposits is so economically large. Even without the deposit inflows, banks in the authors' sample would surely have been able to fund loan commitment drawdowns in interbank markets or through discount window advances at the Federal Reserve (in a period when the Federal Reserve was targeting the federal funds rate, excess demand in the interbank market would simply have led to monetary policy operations that would have the effect of satisfying the demand). Thus, it is difficult to believe that large ex ante transaction balances implied smaller "liquidity risk," because there was essentially no liquidity risk anyway.

It is possible that volatility in transaction deposit volume translates into volatility in bank profits and, as noted, the evidence is persuasive that larger ex ante transaction balances were associated with more volatile bal-

ances during the crisis. By construction, transaction deposits in the authors' data pay no interest, so an increase in such balances must reduce a bank's average cost of funds. Even if the bank is forced to place incremental balances in the interbank market, which is a relatively low-margin investment, every extra dollar of transaction deposits should add to the bank's bottom line. Thus, more volatile transaction deposit balances translate into more volatile profits and more volatile equity prices. But in this story, the volatility is all on the upside. And it is hard to believe the effect is nearly as large as the authors find, because had the inflows into banks been more long-lived, depositors surely would have shifted into interest-bearing accounts. Overall, the authors' findings represent a significant puzzle of interpretation. I hope future research will replicate the result for other episodes and be able to shed light on the details of the relationship between bank equity volatility and transaction deposit volumes.

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Discussion Summary

The general discussion opened with a number of questions of clarification. Discussion then turned to intuition about exactly how liquidity flows are embodied during a crisis and whether bank transaction deposits capture them. *Martin Feldstein* asked whether the price of liquidity changes; that is, whether flows represent a shift in supply or demand. *Richard Evans* gave examples of his experience during the LTCM crisis and around September 11, 2001. In both cases, institutions he worked for and other major dealer banks were flooded with liquid liabilities, and the systemic problem for commercial and central banks was to rapidly recycle such liquidity to where it was needed. *Ken Abbott* observed that the recent appearance of contingent put options and market-disruption put options may compel dealer banks that write such options to make substantial payouts during crisis periods, and thus inflows of liquidity would be helpful. *Peter Garber* observed that many wholesale depositors likely would turn to repos as a safe-haven asset during crises rather than deposits, if only because of the ease with which repos can be arranged. *Til Schuermann* noted that large

CD volumes increased sharply at the time of the LTCM crisis, but only at the shortest maturities.

The remainder of the discussion included a number of suggestions for the authors, flowing from skepticism that refinancing of commercial paper is the whole story, as well as technical concerns. *Casper de Vries* suggested excluding the banks that had financed LTCM in order to limit concerns about simultaneity bias. *Eric Rosengren* suggested close attention to the experience of banks that specialize in transaction processing, noting that many banks in the authors' sample are small and are unlikely to serve commercial paper issuers. *Hashem Pesaran* suggested including trailing volatility in regressions, and *David Modest* suggested using measures of excess volatility; that is, individual equity volatility net of the change in market-wide volatility.