

# A Crisis of Banks as Liquidity Providers

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Viral V. Acharya and Nada Mora<sup>1</sup>

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<sup>1</sup>The views expressed herein are those of the authors and do not necessarily reflect the positions of the Federal Reserve Bank of Kansas City or the Federal Reserve System.

# Introduction

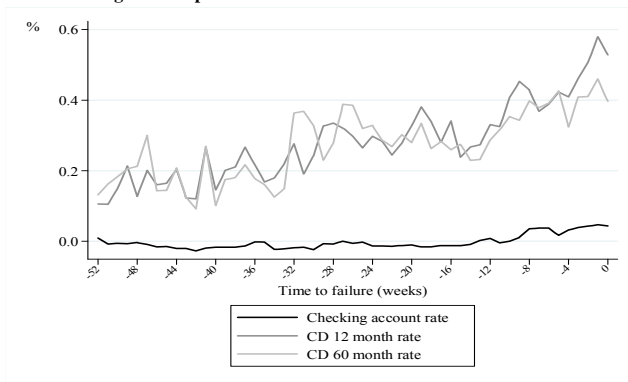
- The starting point of the analysis is the widely accepted notion that banks have a natural advantage in providing liquidity to businesses through credit lines and other commitments established during normal times
- Can banks maintain their advantage as liquidity providers when they are exposed to a financial crisis?
- Or was the onset of the 2007-09 crisis, in effect, a crisis of banks as liquidity providers, which increased the fragility of the financial system?

## Introduction (cont'd)

- Questions were raised in 2007-09 about the solvency of the banking system (Acharya, Schnabl, Suarez (2013), Brunnermeier (2009), Diamond and Rajan (2009))
- As the solvency risk of a bank increases, it might seek to attract deposits by offering higher rates
  - *"The fact that Washington Mutual is now owned by Chase is very positive, because they were a huge outlier on rates"*  
– Ken Lewis, then Chairman and CEO BoA, October 9, 2008

# Survey evidence of current rates (one year prior to failure)

**Figure 1. Deposit Rates: Failed minus Non-Failed Banks**



This figure plots the average of the difference between rates for 43 failed (and nearly failed banks) and rates of banks that did not fail over 1997-2009. Near-fails correspond to the first date when the 18-month return was worse than -90% using daily CRSP equity data. The underlying data are current offered rates from a weekly survey from *Bank Rate Monitor* (BRM); its main advantage is that reported rates reflect marginal funding costs rather than average funding costs (but with the caveat that the survey is on a selection of mostly larger and urban banks and is participation-based).

## Preview (aggregate)

- The main result of this research is that until the government interventions in the fall of 2008 after Lehman's failure, the crisis that began with the ABCP freeze in August 2007 was in fact a crisis of banks in the aggregate; and not just of the weakest banks
  - Aggregate deposit inflows into banks weakened, lending growth outpaced deposit growth, and thus the banking system recorded a loan-to-deposit shortfall throughout the first year of the crisis

# Cumulative deposit growth during the 2007-09 crisis

**Table I. Cumulative Deposit Growth During the 2007-09 Financial Crisis (% change from 2007Q2)**

	2007Q3	2007Q4	2008Q1	2008Q2	2008Q3	2008Q4	2009Q1
<b>Panel A. Large Banks (Largest 25 banks, H8 criteria)</b>							
Insured deposits	0.1	0.8	1.7	1.7	3.9	4.6	5.6
Core deposits	0.2	2.4	3.8	3.4	6.3	9.7	10.8
Large time deposits	0.6	1.5	1.8	1.3	2.8	2.0	1.2
<b>Panel B. Small Banks</b>							
Insured deposits	0.0	0.0	0.7	1.0	2.3	3.0	2.0
Core deposits	-0.4	-0.7	-0.7	-0.5	0.0	0.9	0.5
Large time deposits	1.7	2.4	3.4	3.8	2.7	-0.2	-0.1

All Banks, Core: \$767 billion (Total); \$90 billion (by end-2008Q2); \$272 billion (by early 2009)

All Banks, Large-Time: -\$172 billion (Total); \$53 billion (by end-2008Q2); \$66 billion (by early 2009)

The quarterly data are from Call Reports, where insured deposits are accounts of \$100,000 or less (from 2009Q3, reporting threshold increased to \$250,000), and core deposits exclude large-time and foreign deposits and are commonly seen as stable (include transaction accounts, saving accounts like MMDAs, and CDs less than \$100,000). Core deposits increased by only \$90 bn up until end-2008Q2 (an increase which fell short of average \$130 bn increase in a comparable period for preceding 5 year averages). Core deposits eventually increased in the banking system as a whole by close to \$800 billion by early 2009, but only starting in 2008Q3 when they grew by \$272 bn in just one quarter (see also He, Khang, and Krishnamurthy (2010)).

## Preview (aggregate cont'd)

- The weakness in the aggregate deposit funding position of banks and its sharp reversal following Lehman's failure can be explained by investor perception of greater risk in bank deposits relative to instruments offering similar liquidity and payments services but with more explicit government backing:
  - Federal Home Loan Bank discount notes (Ashcraft, Bech, and Frame (2010))
  - Treasury securities (directly and indirectly through money market mutual funds specializing in government securities)

## Preview (bank level)

- The impact of the aggregate liquidity shock at the onset of the crisis was more pronounced at banks exposed to greater undrawn commitments. Such banks sought to attract deposits by offering higher rates, but the resulting private funding was insufficient to cover loan-to-deposit shortfalls and, unlike previous crises, they were forced to cut back on new credit (new lending and new credit lines)
- In this sense, the role of banks as liquidity providers was itself in crisis during the crisis from 2007 to 2008

## Preview (bank level, cont'd)

- While banks honored their existing credit lines drawn by firms beginning in August 2007 (Ivashina and Scharfstein (2010), Campello et al. (2011), Berrospide, Meisenzahl, and Sullivan (2012)), this provision of liquidity by banks was possible *only* because of explicit, large support from the government and government-sponsored agencies (FHLB advances and Federal Reserve liquidity facilities)
  - E.g., advances from the FHLBs in the first year covered 65% of non-deposit borrowing growth at commitments-exposed banks, while borrowing from the interbank market covered about 25%

# Outline

1. Banks as liquidity providers
2. Liquidity demand risk and individual bank behavior
3. Do liquidity and solvency problems interact?
4. Robustness checks: Timing issues, effective drawdowns, and revisiting Gatev and Strahan (2006)
5. Policy implications and conclusion

## Banks as liquidity providers

- Natural synergy between deposit-taking and commitment lending (Kashyap, Rajan and Stein (2002))
- Even when market stress led to significant drawdowns on banks, they met the increased credit demand because they were awash with funds from depositors seeking a safe haven (LTCM, Enron) (Gatev and Strahan (2006), Pennacchi (2006))

## When the liquidity backup mechanism of the banking system as a whole breaks down

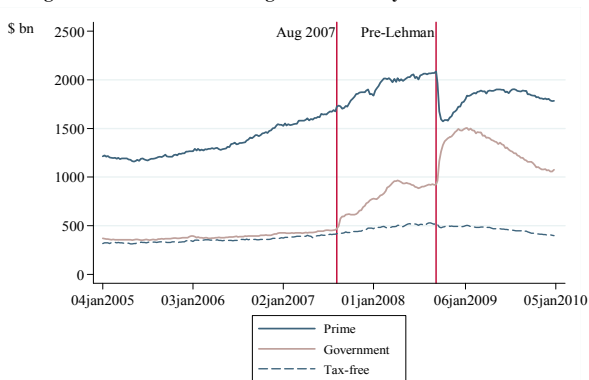
- While it makes sense *ex ante* for banks to combine deposit-taking with commitments, banks may experience *ex post* a coincident liquidity demand from depositors and firms
- In this crisis, investors (households) piled into securities issued or sponsored by the govt., not bank debt that lacked an explicit guarantee (62% of deposits > insurance limit in 07Q2)
  - Lack of information about exposures to subprime shock affected banks collectively (Gorton (2008))
  - Rise in aggregate risk reduced further banks' ability to diversify shocks across businesses and depositors (Acharya, Almeida, and Campello (2013))

## Money market funds

- One main asset through which investors hold Treasuries is through MMMFs specializing in government securities. Generally, both government and prime funds are seen as competing deposit collectors
- Importantly, however, while both government and prime funds received large inflows beginning with the crisis, the increase was significantly greater at govt. funds even prior to Lehman's failure (after which losses at the Reserve Primary Fund caused widespread redemption demands on a range of prime funds)

# The evolution of different money market funds in the crisis

Figure 2a. Assets under management in money market mutual funds

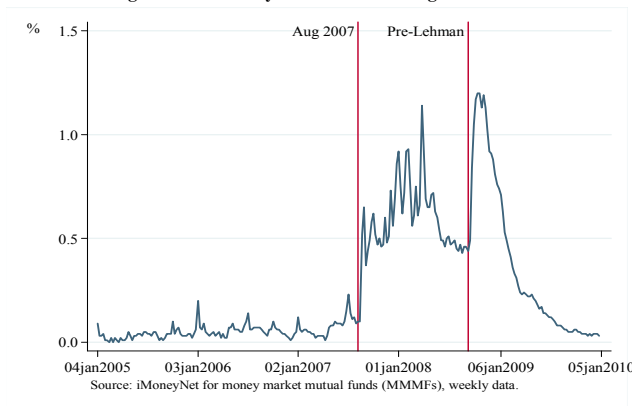


Source: iMoneyNet for money market mutual funds (MMMFs), weekly data.

This figure shows that the flow of investor funds into MMMFs devoted to government securities was greater than into prime funds even before Lehman's and the Reserve Primary Fund's failures. E.g., from 8/2007 to pre-Lehman's failure, the change in govt (prime) funds was \$465 (\$411 bn), the de-trended change in govt (prime) was \$422 (\$182 bn), and the percentage change in govt (prime) was 101% (25%).

# Average investor return differences

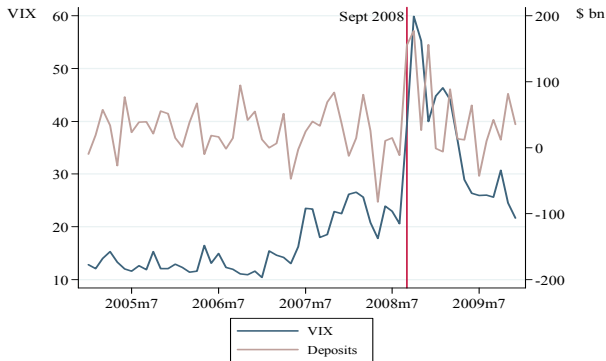
**Figure 2b. MMMF yields: Prime minus government**



The more pronounced inflow into government funds than into prime funds occurred despite a jump in the yield on prime funds relative to government funds.

# The aggregate funding shift following Lehman's failure

**Figure 3. Market Stress and Net Flows into Deposits at Commercial Banks**



Following Lehman's and the Reserve Primary Fund's failures, investor redemptions led to an outflow of \$410 bn from prime funds into government funds (\$238 bn) and into deposit accounts in the banking system (\$189 bn). Concurrently, the government backed the banking system (EESA recapitalizations and increases in deposit insurance; FDIC temporary liquidity guarantee programs including transaction account guarantees (TAG)). The deposit surge was visible across both core and large-time deposits and at both large and small banks.

The inflow of deposit funding finally allowed the banking system as a whole to close its loan-to-deposit shortfall

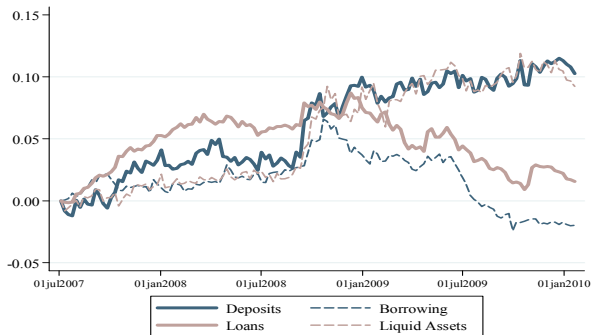
**Figure 4. Panel A. Loan-to-Deposit Shortfalls**

Quarter-on-Quarter Change in the Aggregate Loan-to-Deposit Shortfall (in \$ billions)							
2007Q3	2007Q4	2008Q1	2008Q2	2008Q3	2008Q4	2009Q1	2009Q2
198.1	-32.1	11.3	61.9	-169.4	-253.8	-243.8	-59.4

The inflow of deposits into the banking system following Lehman's failure allowed the banking system as a whole to close its loan-to-deposit shortfall that had opened up during the first year of the crisis. For example, the difference between the increase in lending and in deposits widened to \$198.1 bn by 2007Q3, reached a cumulative \$239.2 bn by 2008Q2, and over \$300 bn in the weeks just prior to Lehman's failure.

# Observed at large banks

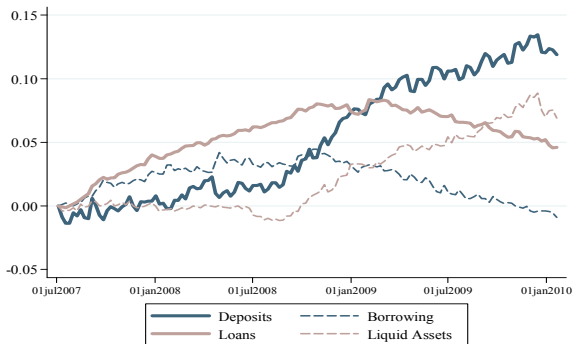
**Panel B. Cumulative Growth of Balance Sheet Components: Large Banks**



On-balance-sheet lending increased, reflecting loan commitment takedowns and mortgage loans that were warehoused because they could no longer be securitized. Other non-deposit non-interbank borrowing helped to support lending growth. Large banks also pulled in funds from related foreign offices (Internet Appendix). Note that large banks are the top 25 U.S. chartered banks as defined in the underlying weekly data from the H8 Release.

## And observed at small banks

**Panel C. Cumulative Growth of Balance Sheet Components: Small Banks**



Small banks saw similar involuntary lending trends as the large banks. Moreover, especially small banks ran down their most liquid assets to support lending and the buildup of assets (reflected in cash assets and the Treasury and Agency securities components of total liquid assets (Internet Appendix)).

## Liquidity demand risk and individual bank behavior

- To test whether a bank at greater risk of credit line drawdowns offers higher rates if it does not gain (or anticipate to gain) proportionate deposits to match its funding needs:

$$\begin{aligned} \text{Deposit Rate}_{i,t} = & \beta_1 \text{liquidity demand risk}_{i,t-1} + \\ & \beta_2 \text{liquidity demand risk}_{i,t-1} \times \text{crisis}_t + \\ & b_i + \tau_t + \text{other controls}_{i,t} + e_{i,t} \end{aligned}$$

- Because our thesis is predicated on the reversal in the aggregate liquidity shock in the latter half of the financial crisis, *crisis* is empirically represented by two dummy variables, *crisis1* (2007Q3-2008Q2) and *crisis2* (2008Q3-2009Q2)

## Main variable definitions

- Key measure of a bank's liquidity demand risk (one quarter lag):  $\text{unused commitments} / (\text{unused commit.} + \text{loans})$ , where unused commit. include business credit lines as well as ABCP not consolidated on balance-sheet (schedule RC-L)  
[note – results robust to non-conduit banks; also to scaling unused commitments by u.c. + assets]
- Dependent variables are rates on large-time and core deposits, implicitly calculated from quarterly Call Reports (interest expense on deposits divided by quarterly average of respective interest-bearing deposits, % annual)  
[note – results similar when using alternative survey data on weekly CD rates]

## Other bank actions

- We also test whether banks took additional actions to meet increased drawdowns. Absent sufficient deposit insurance to ensure adequate core deposit funding and absent sufficient re-intermediation through interbank markets to liquidity constrained banks (we test for both claims), a bank will likely be forced to adjust by cutting back on new credit. Other backup actions include running down liquid assets and seeking out government-sponsored borrowing, e.g.:

$$\frac{\Delta FHLB \text{ borrowing}_{i,t}}{Assets_{i,t-1}} = \beta_1 \text{liquidity demand risk}_{i,t-1} + \beta_2 \text{liquidity demand risk}_{i,t-1} \times \text{crisis}_t + b_i + \tau_t + \text{other controls}_{i,t} + e_{j,t}$$

## Control variables

- Other bank liquidity and solvency measures (one quarter lag)
  - Net wholesale funding dependence (excl. core deposits, incl. non-deposit borrowing less liquid assets such as net federal funds and repos)
  - Nonperforming loan ratio (+90 days and nonaccruals)
  - Capital adequacy (book capital-to-asset)
  - Perceived solvency risk proxied by size (top 25 banks)
  - Share of loans secured by real estate
- Controls also include (in addition to bank, time fixed effects, District time trends) deposit market concentration (defined as branch-weighted geographic market HHI, using branch data from *Summary of Deposits*)

## Other details on bank panel regressions

- Banks belonging to common holding company are aggregated to top holder and treated as single banking organization (Kashyap, Rajan, Stein (2002), Gatev and Strahan (2006))
- Quarterly sample of over 7,000 banking organizations
- Sample excludes smallest banks (assets < \$100 mn)
- Merger effects controlled for by excluding observations when quarterly asset growth rate exceeds threshold (10%)
- Growth rates and deposit rates are winsorized at 1st and 99th percentiles to mitigate effect of outliers
- Standard errors clustered at banking organization level
- Sample is quarterly 1994 to 2009

Table IV. The relationship between the deposit interest rate and liquidity demand risk in the crisis

	(1)	(2)	(3)	(4)
	Large Time	Large Time	Core	Core
Unused commitment ratio <sub>t-1</sub>	0.139 (0.095)	-0.810*** (0.106)	-0.329*** (0.093)	-1.804*** (0.117)
Unused commitment ratio <sub>t-1</sub> × Crisis1	0.592*** (0.119)	0.710*** (0.139)	0.033 (0.095)	0.725*** (0.217)
Unused commitment ratio <sub>t-1</sub> × Crisis2	-0.577*** (0.131)	-0.810*** (0.156)	-0.590*** (0.102)	-0.617*** (0.176)

The results in this slide indicate that banks vulnerable to liquidity demand risk offered significantly higher deposit rates in the first year of the crisis. E.g., a 0.1 increase in the unused commitment ratio (roughly a 1 std. dev. or 75 - 25 percentiles) raised the large-time deposit rate by 5.9-7.1 bps. As funding pressures reversed in the second year of the crisis, these banks offered significantly lower rates in line with Gatev and Strahan (2006).

Table IV. (cont'd)

<i>Controls</i>				
	Large Time	Large Time	Core	Core
Net wholesale funding <sub>t-1</sub>	0.310*** (0.043)	0.529*** (0.036)	0.012 (0.037)	0.890*** (0.044)
Net wholesale funding <sub>t-1</sub> × Crisis1	0.119*** (0.046)	0.162*** (0.053)	0.467*** (0.042)	0.575*** (0.064)
Net wholesale funding <sub>t-1</sub> × Crisis2	0.019 (0.051)	0.066 (0.058)	0.248*** (0.038)	0.312*** (0.059)
NPL to Loans <sub>t-1</sub>	1.073*** (0.236)	0.687** (0.316)	0.218 (0.170)	1.122*** (0.346)
NPL to Loans <sub>t-1</sub> × Crisis1	-0.549 (0.465)	0.302 (0.521)	0.784*** (0.269)	2.302** (0.952)
NPL to Loans <sub>t-1</sub> × Crisis2	1.083*** (0.316)	1.872*** (0.395)	1.050*** (0.209)	2.373*** (0.457)
Capital ratio <sub>t-1</sub>	-0.834** (0.328)	-0.098 (0.223)	-1.834*** (0.260)	0.381 (0.259)
Capital ratio <sub>t-1</sub> × Crisis1	0.775*** (0.220)	0.660*** (0.233)	0.389 (0.306)	0.176 (0.417)
Capital ratio <sub>t-1</sub> × Crisis2	-0.418 (0.317)	-0.804** (0.354)	0.394* (0.218)	-0.542* (0.333)

Table IV. (cont'd)

<i>Controls (cont'd)</i>				
	Large Time	Large Time	Core	Core
Large Bank Indicator	-0.244* (0.146)	-0.204 (0.131)	-0.038 (0.122)	-0.393*** (0.087)
Large Bank Indicator × Crisis1	-0.167 (0.138)	-0.215 (0.163)	-0.307*** (0.073)	-0.664*** (0.093)
Large Bank Indicator × Crisis2	-0.142 (0.103)	-0.133 (0.143)	-0.002 (0.070)	-0.143 (0.094)
Real Estate Loan Share <sub>t-1</sub>	0.025 (0.060)	0.117*** (0.042)	-0.044 (0.054)	-0.021 (0.050)
Real Estate Loan Share <sub>t-1</sub> × Crisis1	-0.066 (0.053)	-0.069 (0.055)	0.058 (0.046)	0.003 (0.070)
Real Estate Loan Share <sub>t-1</sub> × Crisis2	0.109* (0.062)	0.084 (0.077)	0.242*** (0.046)	0.067 (0.072)
Bank Fixed Effects	Yes	No	Yes	No
Observations	196124	196124	196151	196151
R <sup>2</sup>	0.74	0.71	0.89	0.76

Note that the results do not support the alternative that commitments-exposed banks are simply those with solvency problems. E.g., NPLs and real estate loan share were independent risk factors, whose effect did not subside in the second year of the crisis. (e.g., a 1 std. dev. in real estate lending increased the core deposit rate by 5.7 bps in col (3)).

Table V. The relation between deposit flows and liquidity demand risk

	(1)	(2)	(3)	(4)	(5)
	$\Delta \text{ Deposits}_t /$ $\text{Assets}_{t-1}$	$\Delta \text{ Core Deposits}_t /$ $\text{Assets}_{t-1}$	$\Delta \text{ Insured}$ $\text{Deposits}_t /$ $\text{Assets}_{t-1}$	$\Delta \text{ Brokered}$ $\text{Deposits}_t /$ $\text{Assets}_{t-1}$	$\text{TAG Deposits}$ $(2008\text{Q4}) /$ $\text{Assets}_{t-1}$
Unused commitment ratio <sub>t-1</sub>	0.034*** (0.004)	0.025*** (0.003)	0.014*** (0.002)	0.008*** (0.001)	0.174*** (0.016)
Unused commitment ratio <sub>t-1</sub> × Crisis1	-0.016*** (0.006)	-0.017*** (0.005)	0.007 (0.004)	0.007*** (0.002)	
Unused commitment ratio <sub>t-1</sub> × Crisis2	0.018*** (0.006)	0.005 (0.005)	0.030*** (0.004)	0.018*** (0.002)	
Other bank controls included	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	No
Observations	197198	197198	197198	196655	3522
R <sup>2</sup>	0.07	0.08	0.32	0.04	0.14

The slide tests whether there was a change in the relation of deposit flows to a bank's commitments-exposure during the crisis. The results indicate that inflows to banks with high exposure to liquidity demand weakened (despite their offering higher rates), coinciding with the aggregate deposit funding squeeze. E.g., a 0.1 increase in unused commitment ratio was associated with a 0.16-0.17 percentage point decline in quarterly total and core deposit growth, which is economically significant if compare to average core deposit growth of 0.8 percentage point. Consistently, such banks sought more expensive brokered deposits and paid a premium to participate in the FDIC's transaction account guarantee (TAG) program for noninterest bearing transaction deposits of more than \$250,000.

Table VI. The relation between lending, shortfalls, and liquidity demand risk

	(1) $\Delta \text{ Loans}_t / \text{Assets}_{t-1}$	(2) $\Delta \text{ C\&I Loans}_t / \text{Assets}_{t-1}$	(3) $\Delta (\text{Loan} + \text{Commitments})_t / (\text{Assets} + \text{Commitments})_{t-1}$	(4) $(\text{Loans} - \text{Deposits})_t / \text{Assets}_{t-1}$	(5) $\Delta (\text{Loans} - \text{Deposits})_t / \text{Assets}_{t-1}$
Unused commitment ratio <sub>t-1</sub>	0.134*** (0.006)	0.018*** (0.001)	-0.016*** (0.004)	-0.042** (0.017)	0.099*** (0.006)
Unused commitment ratio <sub>t-1</sub> × Crisis1	0.014*** (0.005)	0.004** (0.002)	-0.023*** (0.005)	0.118*** (0.019)	0.028*** (0.007)
Unused commitment ratio <sub>t-1</sub> × Crisis2	-0.002 (0.006)	-0.003 (0.002)	-0.053*** (0.006)	0.095*** (0.017)	-0.021*** (0.007)
Other bank controls included	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	197198	197198	197198	197198	197198
R <sup>2</sup>	0.15	0.03	0.11	0.50	0.10

The next step is to test how commitments-exposed banks adjust lending and other available margins on their balance sheet in response to the liquidity shock. Columns (1) and (2) show that banks with preexisting commitments increased on-balance sheet loan growth in first year as off-balance sheet credit lines were drawn upon and converted to loans. E.g., a 0.1 increase in unused commitment ratio led to a 0.14 p.p. increase in loan growth (firm-level evidence of drawdowns is provided in Campello et al. (2011) and Berrospide and Meisenzahl (2012)). *But* these commitments-exposed banks significantly reduced overall credit (a 0.23 p.p. fall in new credit growth for a 0.1 higher unused commitment ratio). And importantly, while commitments-exposed banks managed to fund credit lines, the shortfall between lending and deposits grew.

Table VII. The possible margins of adjustment available to liquidity-short banks

	(1) $\Delta$ (Liquid Assets) <sub>t</sub> / Assets <sub>t-1</sub>	(2) $\Delta$ (Federal Funds and Repo Borrowing) <sub>t</sub> / Assets <sub>t-1</sub>	(3) $\Delta$ (Other Borrowed Money Total) <sub>t</sub> / Assets <sub>t-1</sub>	(4) $\Delta$ (Other Borrowed Money FHLB) <sub>t</sub> / Assets <sub>t-1</sub>	(5) $\Delta$ (Other Borrowed Money Other) <sub>t</sub> / Assets <sub>t-1</sub>
Unused commitment ratio <sub>t-1</sub>	-0.073*** (0.005)	0.007*** (0.001)	0.012*** (0.002)	0.016*** (0.002)	0.001 (0.000)
Unused commitment ratio <sub>t-1</sub> × Crisis1	-0.011* (0.006)	0.004*** (0.002)	0.013*** (0.002)	0.011*** (0.002)	0.001* (0.001)
Unused commitment ratio <sub>t-1</sub> × Crisis2	0.009 (0.006)	-0.009*** (0.002)	-0.003 (0.003)	-0.004* (0.002)	0.002** (0.001)
Other bank controls included	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	197198	197198	197198	122324	122324
R <sup>2</sup>	0.07	0.02	0.03	0.03	0.01

The loan-to-deposit shortfall in the previous slide implies that a 0.1 increase in preexisting commitments led to a 0.28 percentage point increase in the quarterly difference between lending and deposit growth, compared to a typical zero value. Other borrowing and liquid asset buffers bridged the gap. E.g., the 0.28 p.p. shortfall was funded through a 0.11 p.p. decrease in liquid assets, a 0.04 p.p. increase in interbank borrowing, and a 0.13 p.p. increase in "other borrowed money", primarily from government and government-sponsored agencies (FHLBs). Therefore, the interbank market met only one-quarter of borrowing. Or more simply put, almost the entire increase in lending growth was funded with explicit gov. borrowing.

## Table VI and VII (cont'd). Shortfalls, liquid assets, and non-deposit borrowing at other banks

### *Controls (Capital, NPL, and Large bank also included)*

	(1)	(2)	(3)	(4)
	$\Delta$ (Loans - Deposits) <sub>t</sub> / Assets <sub>t-1</sub>	$\Delta$ (Liquid Assets) <sub>t</sub> / Assets <sub>t-1</sub>	$\Delta$ (Federal Funds and Repo Borrowing) <sub>t</sub> / Assets <sub>t-1</sub>	$\Delta$ (Other Borrowed Money Total) <sub>t</sub> / Assets <sub>t-1</sub>
Net wholesale funding <sub>t-1</sub>	-0.084*** (0.002)	0.067*** (0.002)	-0.010*** (0.000)	-0.010*** (0.001)
Net wholesale funding <sub>t-1</sub> × Crisis1	0.003 (0.002)	0.002 (0.002)	0.000 (0.001)	0.005*** (0.001)
Net wholesale funding <sub>t-1</sub> × Crisis2	-0.022*** (0.003)	0.008*** (0.002)	-0.003*** (0.001)	-0.011*** (0.001)
Real Estate Loan Share <sub>t-1</sub>	0.016*** (0.002)	-0.012*** (0.002)	0.001*** (0.000)	0.002** (0.001)
Real Estate Loan Share <sub>t-1</sub> × Crisis1	0.028*** (0.003)	-0.022*** (0.002)	0.001* (0.001)	0.005*** (0.001)
Real Estate Loan Share <sub>t-1</sub> × Crisis2	0.008*** (0.003)	-0.007*** (0.002)	0.002*** (0.001)	0.001 (0.001)

These results show that the loan-to-deposit shortfall subsided at other liquidity-exposed banks (e.g., banks reliant on wholesale funding) but persisted at real estate exposed banks through the two periods of the crisis. Banks with much real estate lending covered most of their shortfall by running down liquid assets).

## Do liquidity and solvency problems interact?

- Theory predicts a relation between liquidity risk and solvency risk, even when these two risks can be easily separated conceptually
  - Rochet and Vives (2004) show there is a range of fundamentals for which a solvent bank can be illiquid, though this range diminishes as the strength of fundamentals increases or as the adverse selection premium on a bank's asset sales diminishes
  - Diamond and Rajan (2005) show that a higher risk of insolvency leads to a socially detrimental outcome because the bank is forced to sell not only the late project loans but also other loans that would soon deliver real liquidity

# Table VIII. Are banks with solvency problems more vulnerable to liquidity demand risk?

	Panel A. Rate on Large-Time Deposits					
	(1)	(2)	(3)	(4)	(5)	(6)
	Nonperforming Loans	Nonperforming Loans	Real Estate Loan Share	Real Estate Loan Share	Capital Ratio	Capital Ratio
	High	Low	High	Low	High	Low
Unused commitment ratio <sub>t-1</sub>	0.049 (0.129)	0.368*** (0.127)	0.210* (0.114)	0.087 (0.150)	0.173 (0.148)	0.043 (0.124)
Unused commitment ratio <sub>t-1</sub> × Crisis1	0.688*** (0.159)	0.456*** (0.170)	0.651*** (0.140)	0.306* (0.184)	0.577*** (0.191)	0.530*** (0.147)
Unused commitment ratio <sub>t-1</sub> × Crisis2	-0.351** (0.152)	-0.615*** (0.222)	-0.586*** (0.158)	-0.631*** (0.212)	-0.153 (0.209)	-0.826*** (0.159)
Other bank controls included	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	99731	96393	111204	84920	84466	111658
R <sup>2</sup>	0.72	0.74	0.72	0.72	0.71	0.73

These slides test the theory that a bank's vulnerability to liquidity risk is expected to be greater within the class of banks with high solvency problems for a similar ex ante liquidity demand exposure. E.g., a 0.1 increase in unused commitment ratio raised the deposit rate of banks with high NPLs (real estate loans) by 6.9 (6.5) bps compared with 4.6 (3.1) for banks with low solvency risk (statistically significantly different for the real estate loan measure).

Table VIII. (cont'd)

Panel B. Total Deposit Growth						
	(7)	(8)	(9)	(10)	(11)	(12)
	Nonperforming Loans High	Nonperforming Loans Low	Real Estate Loan Share High	Real Estate Loan Share Low	Capital Ratio High	Capital Ratio Low
Unused commitment ratio <sub>t-1</sub>	0.029*** (0.005)	0.037*** (0.005)	0.063*** (0.005)	0.009* (0.005)	0.036*** (0.005)	0.028*** (0.005)
Unused commitment ratio <sub>t-1</sub> × Crisis1	-0.016** (0.007)	-0.013 (0.009)	-0.029*** (0.006)	-0.001 (0.010)	-0.015 (0.009)	-0.015** (0.008)
Unused commitment ratio <sub>t-1</sub> × Crisis2	0.019** (0.008)	0.011 (0.010)	0.020*** (0.007)	0.017* (0.009)	0.021* (0.011)	0.022*** (0.007)
Other bank controls included	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	100013	97185	111329	85869	85178	112020
R <sup>2</sup>	0.08	0.07	0.08	0.08	0.09	0.07

This slide also shows that deposit funding flows were weaker at similarly commitments-exposed banks but with higher solvency risk. Interestingly, though, deposit growth at fundamentally stronger banks shows no evidence of a compensating effect (columns (8), (10), and (12)) and they did not increase interbank and repo lending to other banks (Internet Appendix). That is, banks' advantage as liquidity providers was not restored for even the fundamentally stronger set of banks.

# Table IX. Timing issues: The aggregate shift in funding post-Lehman

	(1) Rate on Large-Time Deposits	(2) $\Delta$ Deposits <sub>t-1</sub> / Assets <sub>t-1</sub>	(3) $\Delta$ (Liquid Assets) <sub>t-1</sub> / Assets <sub>t-1</sub>	(4) $\Delta$ (Loans - Deposits) <sub>t-1</sub> / Assets <sub>t-1</sub>
Unused commitment ratio <sub>t-1</sub>	0.140 (0.095)	0.034*** (0.004)	-0.073*** (0.005)	0.099*** (0.006)
Unused commitment ratio <sub>t-1</sub> × Crisis1	0.594*** (0.120)	-0.016*** (0.006)	-0.011* (0.006)	0.028*** (0.007)
Unused commitment ratio <sub>t-1</sub> × Crisis2 08Q3	-0.315* (0.174)	0.049*** (0.010)	0.030*** (0.010)	-0.058*** (0.012)
Unused commitment ratio <sub>t-1</sub> × Crisis2 08Q4-09Q2	-0.656*** (0.145)	0.008 (0.007)	0.002 (0.007)	-0.007 (0.008)
Other bank controls included (see appendix)	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes
Observations	196124	197198	197198	197198
R <sup>2</sup>	0.74	0.08	0.07	0.10

This slide shows that the very sharp increase in deposits (and liquid assets) at commitments-exposed banks occurred in 2008Q3, not later in the period. Therefore, the position of these banks is directly attributable to the turnaround in liquidity following Lehman's failure (see Internet Appendix for: *i*) additional results deconstructing the crisis into eight quarters and showing that "other borrowed money" growth was sustained throughout the 2007Q4-2008Q2 period; and *ii*) results using an alternative data source (Bank Rate Monitor) at the weekly frequency showing that liquidity risk was highest in the period just before Lehman failed (unlike solvency measures). Rates eased for commitments-exposed banks in the aftermath and then more so after TARP was introduced.

Table X. Partitioning banks by their unused commitments constraint: Effective drawdowns

	(1) Rate on Large- Time Deposits High	(2) Rate on Large- Time Deposits Low	(3) $\Delta$ Deposits/ Assets <sub>t-1</sub> High	(4) $\Delta$ Deposits/ Assets <sub>t-1</sub> Low	(5) $\Delta$ Loans/ Assets <sub>t-1</sub> High	(6) $\Delta$ Loans/ Assets <sub>t-1</sub> Low
Unused commitment ratio <sub>t-1</sub>	0.133 (0.141)	0.090 (0.148)	0.048*** (0.006)	0.022*** (0.005)	0.146*** (0.011)	0.113*** (0.009)
Unused commitment ratio <sub>t-1</sub> × Crisis1	0.748*** (0.160)	0.390** (0.175)	-0.021*** (0.007)	-0.009 (0.009)	0.030*** (0.007)	0.008 (0.006)
Unused commitment ratio <sub>t-1</sub> × Crisis2	-0.555*** (0.212)	-0.619*** (0.164)	0.015 (0.010)	0.019*** (0.007)	0.007 (0.008)	-0.007 (0.008)
Other bank controls included (see appendix)	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	68511	83442	68645	84105	68645	84105
R <sup>2</sup>	0.78	0.75	0.09	0.07	0.22	0.12

This slide reports regressions testing the hypothesis that the crisis should have especially constrained banks with greater effective, not potential, drawdowns. To apply this test empirically, we compare the change in relations for similarly ex ante exposed banks but with above- and below-median declines in their unused commitments, respectively, during the crisis. The results confirm that because banks honored their commitments, on-balance sheet lending of the constrained set significantly increased despite all indications in this and the next slide that they were more stressed. The results also show that while commitments-exposed banks lowered rates roughly equally in the latter part of the crisis when banks were flush with funds, the above-median set saw the sharpest increase in rates at the onset of the crisis (col (1) and (2)).

# Table X. (cont'd)

	(7)	(8)	(9)	(10)	(11)	(12)
	$\Delta$ Brokered Deposits/ Assets <sub>t-1</sub>	$\Delta$ Brokered Deposits/ Assets <sub>t-1</sub>	$\Delta$ (Other Borrowed Money Total)/ Assets <sub>t-1</sub>	$\Delta$ (Other Borrowed Money Total)/ Assets <sub>t-1</sub>	$\Delta$ (Liquid Assets)/ Assets <sub>t-1</sub>	$\Delta$ (Liquid Assets)/ Assets <sub>t-1</sub>
	High	Low	High	Low	High	Low
Unused commitment ratio <sub>t-1</sub>	0.011*** (0.002)	0.006*** (0.001)	0.011*** (0.002)	0.011*** (0.003)	-0.073*** (0.008)	-0.068*** (0.007)
Unused commitment ratio <sub>t-1</sub> × Crisis1	0.010*** (0.003)	0.004 (0.004)	0.017*** (0.004)	0.010*** (0.003)	-0.027*** (0.006)	-0.001 (0.009)
Unused commitment ratio <sub>t-1</sub> × Crisis2	0.026*** (0.003)	0.011*** (0.003)	-0.001 (0.004)	-0.003 (0.003)	-0.001 (0.009)	0.016** (0.008)
Other bank controls included (see appendix)	Yes	Yes	Yes	Yes	Yes	Yes
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	68567	83787	68645	84105	68645	84105
R <sup>2</sup>	0.06	0.03	0.04	0.03	0.07	0.08

This slide provides additional evidence that banks that saw greater on-balance sheet lending through drawdowns of commitments were significantly more stressed. E.g., they reduced their liquid asset growth by 0.27 p.p. for a 0.1 increase in their ex ante commitments-exposure.

Table XI. The relationship between market stress and growth of deposits and nondeposit liabilities: Was it different in the 2007-09 crisis?

	(1)	(2)	(3)	(4)	(5)	(6)
	$\Delta \text{Deposits}_t / \text{Assets}_{t-1}$			$\Delta \text{Nondeposit Liabilities}_t / \text{Assets}_{t-1}$		
	Gatev and Strahan sample 1991-2000	1990-2009	1990-2009	Gatev and Strahan sample 1991-2000	1990-2009	1990-2009
Unused commitment ratio <sub>t-1</sub>	-0.021*** (0.007)	0.025*** (0.003)	0.025*** (0.003)	0.021*** (0.005)	0.013*** (0.002)	0.016*** (0.002)
<b>Unused commitment ratio<sub>t-1</sub> × Stress</b>	<b>0.041*** (0.011)</b>	<b>0.007 (0.005)</b>	<b>0.022*** (0.008)</b>	<b>-0.004 (0.008)</b>	<b>0.006* (0.003)</b>	<b>-0.007 (0.006)</b>
<b>Unused commitment ratio<sub>t-1</sub> × Stress × Crisis1</b>			<b>-0.039** (0.017)</b>			<b>0.029** (0.013)</b>
<b>Unused commitment ratio<sub>t-1</sub> × Stress × Crisis2</b>			<b>0.018 (0.013)</b>			<b>0.014 (0.009)</b>
Unused commitment ratio <sub>t-1</sub> × Crisis1			0.004 (0.014)			-0.003 (0.009)
Unused commitment ratio <sub>t-1</sub> × Crisis2			-0.011 (0.007)			-0.016*** (0.004)
<b>Controls</b>						
Capital ratio and interactions with stress and crisis	Yes	Yes	Yes	Yes	Yes	Yes
Size and interactions with stress and crisis	Yes	Yes	Yes	Yes	Yes	Yes

Note that *stress* is proxied by the commercial paper spread and the model allows for a change in the slope of the relation between balance sheet adjustment and commitments-exposure in the crisis compared with previous episodes of stress. This slide shows that banks that had offered insurance to nonfinancial borrowers before the crisis were not as well positioned to deliver the promised liquidity. E.g., before the 2007-09 crisis, an increase in the CP spread by 100 bps increased deposit growth 0.22 p.p. more at 75th percentile bank than at 25th percentile bank (characterized by a 0.1 difference in their unused commitment ratio). But in *crisis1*, an increase in CP spread by 100 bps contracted growth 0.17 p.p. more at the 75th percentile bank.

Table XII. The relationship between market stress and growth of real sector credit: Was it different in the 2007-09 crisis?

	(1)	(2)	(3)	(4)	(5)	(6)
		$\Delta \text{Loans}_i / \text{Assets}_{i-1}$			$\Delta (\text{Loan} + \text{Commitments})_i / (\text{Assets} + \text{Commitments})_{i-1}$	
	Gatev and Strahan sample 1991-2000	1990-2009	1990-2009	Gatev and Strahan sample 1991-2000	1990-2009	1990-2009
Unused commitment ratio <sub><i>t-1</i></sub>	0.087*** (0.010)	0.110*** (0.007)	0.113*** (0.007)	-0.009 (0.010)	0.014*** (0.004)	0.023*** (0.004)
<b>Unused commitment ratio<sub><i>t-1</i></sub> × Stress</b>	<b>0.047*** (0.012)</b>	<b>0.004 (0.005)</b>	<b>0.032*** (0.009)</b>	<b>0.031*** (0.011)</b>	<b>-0.035*** (0.006)</b>	<b>0.018* (0.009)</b>
<b>Unused commitment ratio<sub><i>t-1</i></sub> × Stress × Crisis1</b>			<b>-0.020 (0.018)</b>			<b>0.026 (0.018)</b>
<b>Unused commitment ratio<sub><i>t-1</i></sub> × Stress × Crisis2</b>			<b>-0.023* (0.013)</b>			<b>-0.026* (0.015)</b>
Unused commitment ratio <sub><i>t-1</i></sub> × Crisis1			-0.004 (0.013)			-0.067*** (0.014)
Unused commitment ratio <sub><i>t-1</i></sub> × Crisis2			-0.021*** (0.006)			-0.053*** (0.008)
<b>Controls</b>						
Capital ratio and interactions with stress and crisis	Yes	Yes	Yes	Yes	Yes	Yes
Size and interactions with stress and crisis	Yes	Yes	Yes	Yes	Yes	Yes

Note that *stress* is proxied by the commercial paper spread. This slide shows that lending growth at commitments-exposed banks significantly declined in the second year while total new credit growth (loans + commitments) declined throughout the crisis. In contrast, earlier stress events saw robust credit growth.

# Conclusion

- Banks seem to have *only* partly helped avoid financial disruptions and business liquidations that would have occurred in the absence of a liquidity backstop by the central bank and the government during the 2007-09 crisis
- ⇒ Policymakers need to design alternative mechanisms to ensure an uninterrupted supply of credit to creditworthy borrowers (e.g., ex post interventions like the Fed's Commercial Paper Funding Facility; ex ante better charging for deposit insurance (Acharya, Santos, and Yorulmazer (2010)) and better liquidity regulation in the form of Basel III Liquidity Coverage Ratio and priced access to central bank liquidity facilities (because ex post interventions can be socially costly; Stein (2013)))