Crises, Liquidity Shocks, and Fire Sales at Commercial Banks

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If liquidity shortages cause financial crises, a lender of last resort can provide funds to banks facing potential fire sales. However, if funding problems primarily occur at banks with existing solvency problems, then government liquidity programs may not spur bank lending. We find that commercial bank funding does not typically dry up in a crisis, not even during the subprime crisis. Rather, weak banks are more likely to borrow less. Furthermore, banks rely more on deposits and newly issued equity than fire sales. When they do sell assets, they cherry pick assets in order to alleviate pressure from capital regulations.

What causes a financial crisis to snowball into major problems for the whole economy: liquidity or insolvency? During the subprime crisis, regulators frequently alluded to "frozen debt markets" and offered a host of liquidity facilities to promote bank lending to nonfinancial firms. As in past crises, the Federal Reserve ("Fed") played the role of "lender of last resort" and attempted to reduce frictions in capital markets that could hinder banks' access to funds.

Extraordinary liquidity programs are justified if crises inhibit capital markets from appropriately allocating credit. However, these programs may not work if credit allocation declines for other reasons. In particular, if declining asset values drive some banks closer to insolvency, then capital market participants may not be willing to provide funding to these banks in any circumstances. Further, if extending emergency credit to banks props up inefficient institutions that are best left to fail, these programs may even be counterproductive in the long run. Without understanding the underlying cause of capital market disruptions, simply providing liquidity may not address the underlying factors and avert a full blown recession.

In this paper, we investigate which factor, liquidity or insolvency, is more important for financial crises. In particular, we examine bank borrowing to determine if money is scarce across the board, as liquidity shock explanations imply, or if capital market lenders cut off particularly weak banks

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due to credit concerns. Further, to the extent that banks face debt shortfalls, we examine their strategies for replacing the lost funds. Under the liquidity hypothesis, debt markets tighten, forcing banks to sell assets. However, under the solvency hypothesis, nearly insolvent banks will instead issue equity, cut dividends, and raise deposits before selling assets. For banks that must sell assets, the solvency hypothesis predicts that banks will cherry pick their assets, thus improving their equity capital. Cherry picking is a regulatory arbitrage strategy of realizing gains on appreciated assets while avoiding selling assets with declining market values. Only after exhausting all of these options will banks resort to fire sales (i.e., selling assets at a realized loss).

We use data on commercial banks from 1980 to 2008 to evaluate these two explanations of financial crises. Most commercial banks do not experience declines in funding during crises, which runs counter to the main element of liquidity shock theories. Banks that usually rely on capital markets to fund their loans continue to issue new debt during crises, although at a slower pace than during booms. This result holds for the recent subprime crisis, even after controlling for funding from the Fed and the Federal Home Loan Bank (FHLB). Importantly, the majority of banks that need funds in a crisis are not troubled by illiquid markets, but rather by their own balance sheets. They enter the crisis in worse financial condition than other banks. Moreover, when banks experience difficulties in rolling over debt, their troubles do not usually lead to asset sales. Instead, banks rely more on deposits, issue equity, and sell off noncore assets at prices that improve, not deplete, their reported capital positions. Overall, we conclude that financial crises are defined primarily by insolvency concerns rather than by frozen debt markets. Consequently, some banks begin the crisis in such a weakened state that capital markets refuse to roll over their short-term funding.

In the next section, we discuss the literature and develop our hypotheses. Section II summarizes our data, Section III presents our empirical results, and Section IV reports our sensitivity analyses. Section V provides our conclusions.

I. Literature and Analytical Framework

A. Previous Research on Bank Liquidity and Insolvency in Financial Crises

A number of theories link bank liquidity problems to financial crises. For example, Allen and Gale (2000) assume that a shortage of funds at one bank can trigger a crisis through the interbank borrowing markets. Likewise, a number of papers, including Allen and Carletti (2006), Diamond and Rajan (2011), Krishnamurthy (2009), Brunnermeier and Pedersen (2009), Froot (2010), Uhlig (2010), Gromb and Vayanos (2002), Adrian and Shin (2008, 2010), Geanakoplos (2009), and Korinek (2011), focus on aggregate liquidity shortages that force banks to meet debt maturities by selling assets into a falling market. Such fire sales are consistent with the theory in Shleifer and Vishny (1992), which highlights the fact that shortages of knowledgeable buyers in a downturn can cause sales at prices well below fundamental values.

An alternative point of view is that crises arise when fundamental values of major asset classes have fallen (Eisenbeis, 2009; Kane, 2009). These declines reflect reduced growth opportunities and can cause some banks to become insolvent, or nearly so (Kashyap and Stein, 2004; Kahle and Stulz, 2013). Consequently, many banks experience difficulties in obtaining new capital, as predicted by Myers (1977).

The existing empirical literature provides indirect evidence consistent with both perspectives. Specifically, studies by Ashcraft, Beck, and Frame (2010), Acharya and Merrouche (2013), and Beltratti and Stulz (2012) provide evidence that the recent financial crisis had the greatest negative

impact on banks that borrow in short-term capital markets. Gorton and Metrick (2012) provide evidence that short-term funding was constrained by a run on the repo market. Both of these results are consistent with the liquidity view of crises. In contrast, results in Kahle and Stulz (2013), Kashyap and Stein (1995), Cohen-Cole et al. (2010), and Afonso, Kovner, and Schoar (2011) suggest that reduced borrowing in crises reflects lower demand for funds or difficulties related to solvency concerns. Berger and Bouwman (2013) find that banks with less capital prior to the onset of a crisis are less likely to survive and more likely to lose market share, suggesting that an ability to withstand shocks to fundamental asset values and avoid insolvency is a major concern for bank creditors in a crisis.

If illiquid capital markets constrain banks' access to funds, then funding problems may force banks to sell off assets. Again, the empirical literature provides indirect evidence consistent with both the liquidity and the solvency views of crises. Analyses in Santos (2011), Adrian and Shin (2010), Acharya, Shin, and Yorulmazer (2011), Greenwood, Landier, and Thesmar (2011), and Shleifer and Vishny (2011) indicate that banking activity is curtailed in a crisis as the banks adjust their balance sheets to deal with funding shortages. However, Demsetz (1993) finds that commercial banks sold fewer assets during the 1990-1991 credit crunch and Boyson, Helwege, and Jindra (2012, 2013a) find evidence of cherry picking rather than fire sales during crises. Chari, Christiano, and Kehoe (2008) and He, Khang, and Krishnamurthy (2010) highlight commercial bank data that show asset growth in the recent crisis. Ivashina and Scharfstein (2010) and Acharya and Richardson (2009) attribute this growth to "involuntary" factors in that the growth arises from contracts that were written before the crisis.[1] While these factors may cause additional funding problems for banks, growth is only possible if debt or equity also expands. Iyer et al. (2013) examine the effects of a freeze in the European interbank market and find that banks hoard cash as a result, but assets do not decline.

Our study contributes to the existing literature by studying a sample of large banks during several crisis periods. We directly examine whether outcomes affecting commercial banks during crises are consistent with the existence of liquidity shocks or whether they are instead consistent with insolvency concerns caused by shocks to fundamentals.

B. Analytical Framework

We investigate the two competing explanations of financial crises by focusing on four key elements of the liquidity shock and insolvency channels: 1) funding problems at banks, 2) liability management (i.e., strategies for replacing lost funding), 3) characteristics of bank asset sales, and 4) causes of bank distress. We compare banks in booms and crises to determine the importance of these four elements when market conditions deteriorate.

The first element of the liquidity explanation of financial crises is that funding problems originate with a shortage of debt financing that affects all banks. Banks that rely on short-term capital market funding (e.g., repos and commercial paper) are most troubled by this shortage. Second, the liquidity theories assume that funding problems will trigger asset sales. Third, these asset sales will occur at unusually low prices. These three assumptions lead to the prediction that low asset prices arise from liquidity shocks. Further, the models predict that losses on asset sales will be large enough to prevent banks from meeting their debt obligations, pushing these banks toward insolvency. Thus, the liquidity models also predict that funding shortages cause distress.

For each of the four components of the liquidity explanation of crises, the insolvency framework provides a contrasting prediction. If crises are triggered by shocks to fundamental asset values,

[1] Ivashina and Scharfstein (2010) focus on lines of credit that were suddenly borrowed against in the crisis, while Acharya and Richardson (2009) analyze conduits that banks were forced to bring back onto their balance sheets.

then a sharp decline in expected profitability will cause banks with low equity capital to veer toward insolvency. As in Myers (1977), these banks will have trouble raising new capital, and funding problems will be concentrated among the least creditworthy banks. Rather than fire sales, the insolvency explanation predicts that these banks will seek alternative methods of dealing with funding declines. For the third element, if banks resort to asset sales, these sales will instead involve cherry picking of assets that allows the banks to improve their capital. Finally, the fourth aspect of the solvency framework is that distress is concentrated among those banks that began the crisis with the weakest balance sheets.

Our first test considers the types of banks that experience debt shortfalls. Specifically:

H1 (Debt shortfall hypotheses):
H1A (Liquidity): If capital markets do not function in a crisis due to liquidity shocks, funding will be cut off for most banks. Banks that rely the most on short-term debt will have the most severe funding problems.
H1B (Insolvency): Capital markets continue to allocate credit during a crisis and will cut off funding to banks with riskier balance sheets. Thus, debt shortfalls will be concentrated among insolvent or nearly insolvent banks.

We test the liquidity debt shortfall hypothesis (H1A) by assessing bank reliance on short-term debt scaled by assets, measured in the quarter immediately prior to a crisis or boom. We measure these, as well as solvency characteristics, in the quarter immediately prior to a crisis or boom in order to avoid changes that may result from shocks that occur during the cycle. Reliance on short-term debt is calculated by splitting the sample into quartiles and creating indicator variables for the banks with high or low amounts of short-term debt. If liquidity dries up in a crisis, then banks with the most short-term debt should experience the largest decline in debt funding. If instead, solvency concerns stemming from declines in asset values trigger financial crises, then debt shortfalls will more often occur at banks that began the crisis period in a weaker position (Calomiris and Mason, 1997). We test the insolvency debt shortfall hypothesis (H1B) by assessing the banks' equity capital ratios, *Z* scores (Laeven and Levine, 2009), and short-term debt credit ratings. Specifically, H1B predicts that the quartile with the least creditworthy banks (measured by capital or *Z* score) and the banks with the lowest credit ratings will face the largest debt shortfalls.

Next, we consider how banks deal with debt shortfalls. By assumption, the liquidity shock theories rule out new equity issuance and the restructuring of debt contracts and instead assume that banks must sell off assets to repay short-term debt. For example, Diamond and Rajan (2011) assume in their model that "banks face a common liquidity shock . . . .[As a result,] the bank will have to sell some of its assets for cash to meet this liquidity demand." Thus, our second set of hypotheses relates to the empirical validity of this assumption:

H2 (Liability management hypotheses):
H2A (Liquidity): Capital market liquidity shocks force affected banks to repay short-term debt with proceeds from asset sales.
H2B (Insolvency): Banks that face debt shortfalls do not rely solely on asset sales to repay short-term debt, but replace lost debt funding in other ways as well.

H2A will be accepted, and H2B rejected, if banks cannot raise new equity capital, cut dividends, or reduce stock repurchases. Likewise, the liquidity shock models will be supported if they are correct in assuming that short-term debt shocks cannot be dealt with through increased reliance on deposits or borrowing from the government. The literature indicates that strong and weak

banks alike would prefer to avoid issuing new equity in normal times, but Cornett and Tehranian (1994) and Cornett, Mehran, and Tehranian (1998) show that regulatory pressure on banks to raise equity in downturns reduces information problems, suggesting that it has a lower relative cost in a crisis. However, the last crisis was described as one with frozen debt markets and this likely implies frozen equity markets as well so that banks may not be able to raise equity in all crises. Furthermore, the extent to which distressed firms will be able to issue equity also depends on whether the firm has a debt overhang problem (Myers, 1977). If new equity only serves as a wealth transfer to existing debt holders, undercapitalized banks would not issue equity even if equity markets were not frozen.

Another alternative, cutting dividends and/or reducing stock repurchases, is feasible even when capital markets are disrupted. While all banks would like to avoid the 10% average drop in market value associated with a dividend cut (Slovin, Sushka, and Polonchek, 1999), this price drop is far preferable to outright failure and may be a viable strategy for dealing with a decline in debt funding.

It may be possible for banks to compensate for the shortfalls in repo borrowing, commercial paper issuance, and bond issuance with other forms of debt. In particular, they can substitute these capital market instruments with deposits, discount window loans, and FHLB loans. These sources of funding are available in all crises during our sample period, and several emergency programs (considered separately below) also could have replaced short-term debt during the subprime crisis. Kane (1989) highlights that even insolvent banks can continue to borrow from depositors if Federal Deposit Insurance Corporation (FDIC) deposit insurance is credible. Prior research also suggests that individuals seek a safe haven in turbulent times, leading to increased deposits at banks during crises (Gatev and Strahan, 2006; Gatev, Schuermann, and Strahan, 2009; Cornett et al., 2011). Further, banks may prefer the discount window to fire sales in a crisis despite the associated stigma (Furfine, 2001; Armantier et al., 2011). Finally, as Ashcraft et al. (2010) point out, FHLB loans provide a source of inexpensive short-term borrowing in a crisis. We investigate banks with funding shortfalls to determine if they replace capital market debt with deposits and government loans.

We note that the existence of some asset sales does not invalidate H2B if these sales are not the only action banks take to replace lost funding during a crisis. Furthermore, if asset sales occur at prices that bolster equity, which is especially important for banks entering the crisis with little equity and for banks that find equity issuance costly, the insolvency framework will remain valid.

Our third set of hypotheses focuses on whether asset sales create loss spirals in a crisis:

H3 (Fire sale hypotheses):
H3A (Liquidity): Bank asset sales in a crisis occur at fire sale prices. That is, assets are sold at values that are well below their fundamental values.
H3B (Insolvency): Bank asset sales in a crisis reflect cherry picking, where the assets sold have appreciated in value.

We test these hypotheses by seeking evidence of fire sales among banks that experience debt shortages. Without knowing the true fundamental value of an asset, we cannot say whether the price received for an asset in a crisis is so low as to constitute a fire sale. However, several liquidity-based theories of financial crises characterize a sale as a fire sale when the price received for the asset is below the value of the debt borrowed to finance the asset. Since the debt repayment equals the face value of the debt—the value carried on the bank's balance sheet—a fire sale would have to cause a realized loss on the sale of the asset. Liquidity-based theories of financial crises imply that banks with the greatest reliance on capital markets funding will suffer the most

from fire sales. Thus, we test H3A by examining if banks most reliant on short-term debt funding experience the highest realized losses.

H3B predicts that struggling banks will avoid fire sales and instead sell assets that do not deplete their capital (they will cherry pick assets). Cherry picking refers to the decision to sell assets with unrealized gains and avoid selling assets with unrealized losses. Since loans and many other assets are not marked to market, and accounting rules treat losses and gains on loans asymmetrically, sales of appreciated assets often result in capital gains. Thus, cherry picking serves the additional purpose of raising regulatory capital (Moyer, 1990; Ahmed and Takeda, 1995; Beatty, Chamberlain, and Magliolo, 1995) and should be more appealing to banks affected most negatively by shocks to fundamentals. An example of cherry picking is the sale of JPMorgan Chase's Paymentech Solutions in December 2008 for a reported gain of $1 billion. Cherry picking leads to gains that help offset portfolio losses while at the same time shrinking the asset base. Fewer assets help further to raise banks' equity ratios by reducing the denominator of the capital ratio (Berger et al., 2008).

Finally, we propose the following cause of distress hypotheses:

H4 (Cause of distress hypotheses):
H4A (Liquidity): Liquidity shocks cause both debt shortfalls and fire sales whose combined effects push firms toward distress.
H4B (Insolvency): Distress occurs more often among banks that have a shortage of capital at the onset of the crisis.

The liquidity shock amplification models generate a larger risk of bank distress because funding problems lead to asset sales, and those sales involve significant losses (H4A). An alternative explanation for bank distress is that some banks begin the crisis with inadequate capital cushions and these cushions evaporate faster during crises when losses on their portfolios are greater (H4B). To differentiate these hypotheses, we must separate losses that occur as a result of liquidity shocks from those that reflect precrisis investment decisions. We do this with three approaches. First, we measure the size of the capital cushion in the quarter before the crisis and create indicator variables related to bank capital (those used to test H1B). Second, we analyze bank responses to funding problems. If H3A is true, then a bank facing a funding shortfall would sell assets at fire sale prices, which could cause distress (H4A would hold). In contrast, if H2B and H3B are true (banks replace lost funding with deposits, equity, or cherry picking), then low capital is not attributable to liquidity shocks and H4A will be rejected. Third, we consider whether banks with declining assets in a crisis write down assets or sell assets at a loss. If banks write down assets, these losses are consistent with shocks to fundamentals that push the bank toward insolvency (i.e., we accept H4B). In contrast, banks are not required to write down assets in a crisis if their values are only affected by temporary liquidity shocks.

II. Data

To classify crises, booms, and neutral periods, we categorize quarters in the 1980-2008 period by examining National Bureau of Economic Research (NBER) cycles, bank failures, the TED spread, Moody's Aaa-Baa bond spreads, flights to quality (Collin-Dufresne, Goldstein, and Helwege, 2009), the Long-Term Capital Management (LTCM) episode, and credit crunches (Bordo and Haubrich, 2010). We correlate the top quartile of in-sample monthly distributions of bank failures, TED, and credit spreads, and the bottom quartile of stock market quarterly returns with monthly data on NBER recessions, flight to quality episodes, and LTCM's failure. Positive (negative)

Table I. Crisis and Boom Periods

This table reports the periods of booms and crisis as determined by in-sample distribution of the following indicators: NBER recessions and expansions, bank failures (normalized by the contemporaneous number of banks), TED spread, Moody's AAA-Baa credit spreads, flight to quality indicators (Collin-Dufresne et al., 2009), Long-Term Capital Management (LTCM) episodes, stock market declines and increases, and credit crunch periods (Bordo and Haubrich, Bordo and Haubrich 2010).

Periods	Dates	Notes
Crisis	1/1980-11/1982	- NBER contraction (1/1980-6/1981) - High TED and credit spreads - Flight to quality in late 1982 - Credit crunch early 1980 - Low stock market returns in 1980 and 1981
	12/1988-12/1992	- NBER contraction (7/1990-3/1991) - High bank failures (S&L crisis) - Periods of high TED spread - Flight to quality - Credit crunch - Low stock market returns
	8/1998-1/1999	- High TED spread - Flight to quality - LTCM episode - Low stock market returns
	3/2001-11/2001	- NBER contraction (3/2001-11/2001) - Flight to quality - Low stock market returns
	3/2007-12/2008	- NBER contraction (12/2007-6/2009) - High bank failures - High TED and credit spreads - Flight to quality - Credit crunch - Low stock market returns
Boom	11/1993-10/1997	- NBER expansion - Low bank failures - Low TED and credit spreads - High stock market returns
	6/1999-5/2000	- NBER expansion - High stock market returns
	1/2003-2/2004	- NBER expansion - Low credit spreads - High stock market returns

outcome quartiles are boom (crisis) periods, while the middle two quartiles (neutral periods) are excluded from the analysis to reduce noise.

Our classification results in five crisis and three boom periods, illustrated in Table I. Our tests use quarterly data on bank balance sheets. As such, for a particular observation to be classified as occurring during a crisis (boom) period, the troubles (good times) must last for the full fiscal quarter. Thus, short crises, like the September 11, 2001 episode or the stock market crash of 1987, are excluded from our analysis.

We identify commercial banks from the Compustat Quarterly Bank and Thrift data set, which covers approximately 1,750 commercial banks. When a bank, such as Citigroup, changes its standard industrial classification (SIC) code from commercial banking to investment banking, it is excluded from the sample at that point in time. We include the largest 10% of banks, since smaller banks that rely primarily on deposits are less likely to be affected by liquidity shocks to capital markets. Kashyap and Stein (1995) show large banks account for most of the lending in the economy (the top 10% have over 75% of all banking system assets and the top 1% account for half of such assets). Thus, by studying only the largest banks, we focus on institutions with the most exposure to liquidity shocks while maintaining a representative sample of U.S. banking. To mitigate survivorship bias, we use all of the banks that fall into the top decile of total assets in at least one quarter during our sample period. Our final sample contains 168 unique banks, ranging in any given quarter from 56 to 129, including some foreign banks (about 10% of our firm-quarter observations). Center for Research in Security Pricing (CRSP) delisting codes indicate that banks leave our sample due to mergers (95 instances) or being dropped by the exchange (12 cases). Based on the list of failed banks on the FDIC's website, five banks failed during the sample period.[2] Our sample of large banks is comparable to Kashyap and Stein's (1995) top 1% bank sample based on Call Report data in Q2 1984, although their sample of 142 banks is larger than our 94 banks in 1984 because Compustat covers only those banks with publicly traded equity.

We supplement these data with commercial bank asset sales data reported by Thomson Reuters' Securities Data Corporation (SDC). We use Compustat data on net gains on asset sales prior to 1993, but, because of an accounting rule that takes effect that year, the definition changes to include write-downs as well. We hand collect data on net gains and losses from footnotes in 10-K filings with the Securities Exchange Commission's (SEC's) EDGAR system to complete this variable for 1998, 2001, and 2007-2008. Due to the lack of data availability, we estimate some cash flow statement variables using their counterparts calculated from balance sheet data. We ascertain that the two are comparable with two checks. First, we compare the results using periods when both balance sheet and detailed cash flow data are available. Second, we use financial statement data from EDGAR filings and SDC data on long-term debt issuance to confirm that our estimates of cash flow items are correct. We obtain short-term debt ratings from Compustat. When they are not available, we use long-term debt ratings converted according to Standard & Poor's Rating Correlation Scales.

We also consider the use of government programs in the most recent crisis by analyzing data from the Federal Reserve's website, individual company 10-K filings, and from the Fed's response to a Freedom of Information Act (FOIA) request on March 31, 2011. Prior to the subprime crisis, large commercial banks rarely used government programs such as the discount window (Peristiani, 1998). Thus, we ignore their impact on our sample for these earlier periods. The FOIA data are described in detail in Boyson, Helwege, and Jindra (2013b). Finally, we use data on institutions using FHLB advances listed in quarterly reports by the FHLB Office of Finance to supplement missing information in Compustat.[3]

We present summary statistics in Table II. The average (median) of assets is $66 billion ($15 billion). On average, banks experience 3.49% quarterly growth in assets, although some experience shrinkage, as the first quartile of asset growth is negative. Not surprisingly, loans represent the majority of assets, and deposits are the main funding source with short-term debt

[2] If a bank fails, we include it up to the quarter immediately preceding its failure. The failed banks are MCorp, First Republic Bank, Bank of New England, Downey Financial, and Washington Mutual. Only the last two (both well known for extensive losses on risky mortgages) failed in the subprime crisis.

[3] http://www.fhlb-of.com/ofweb_userWeb/pageBuilder/fhlbank-financial-data-36.

Table II. Sample Characteristics

The sample is composed of all of the banks covered by Compustat Quarterly Bank and Thrift data falling into the top 10% of all banks by asset size during at least one quarter during the sample period. Failed banks are included until the date of their failure (per FDIC website). Change in Assets is the quarterly asset growth rate. Loans, Deposits, Short-Term Debt, and Long-Term Debt are loans net of allowance for total loan losses, total deposits, short-term debt, and long-term debt, respectively. Net Debt Issuance, if not available on Compustat, is equal to the change in debt (short-term and long-term) in the current quarter. Equity ratio is shareholders' equity divided by total assets. Issued Equity Indicator is based on net equity issuance that is calculated as sales minus the purchase of common and preferred stock. If data on the sale and purchase of stock are not available, the net equity issuance is estimated as the change in shareholder equity less the change in retained earnings. A-1 Rating Indicator is equal to one if the short-term debt is rated A-1 and zero otherwise. Net Gain on Actual Sec. Sale is obtained from Compustat (item isgtq "Investment Securities – Gain (Loss) – Total") for the period prior to 1993 and is hand-collected from SEC quarterly filings for subsequent crises. Only observations with nonzero figures are used in calculating the mean and median. *Z* Score is calculated as the sum of quarterly return on assets and the equity ratio divided by the volatility of the return on assets. Acquisition/SDC Divestiture Indicator is equal to one if acquisitions/divestitures occur during a particular quarter and zero otherwise.

(*N* = 10,826 Bank Quarters)	Ave	Q1	Median	Q3
Total Assets (TA)	66,259	6,523	15,181	41,056
Change in Assets	3.49%	−0.23%	1.93%	4.68%
Loans/TA	58.86%	53.12%	60.66%	66.54%
Deposits/TA	70.41%	63.82%	71.38%	78.79%
Short-Term Debt/TA	10.38%	4.56%	9.49%	14.68%
Long-Term Debt/TA	7.55%	1.68%	4.09%	10.99%
Net Debt Issuance/Lag(TA)	0.69%	−0.85%	0.40%	1.95%
Equity Ratio	7.03%	5.54%	6.78%	8.25%
Issued Equity Indicator	65.55%			
A-1 Rating Indicator	42.63%			
Net Gain on Actual Sec. Sales/Lag(Sh. Equity)	0.14%	−0.01%	0.03%	0.20%
Net Gain on Actual Sec. Sales > 0	68.35%			
Z Score	89.44	26.35	55.56	112.01
Acquisition Indicator	10.59%			
SDC Divestiture Indicator	4.44%			

averaging 10% of assets. There are approximately 300 observations with zero short-term debt before either a crisis or boom. We examine the robustness of our findings to the presence of these banks in our sample in Section IV. The cross-sectional variation in short-term debt is substantial—the third quartile value is three times the first quartile value. Long-term debt to total assets averages about 8%. Net debt issuance is 0.69% of assets, on average, but the first quartile of net debt issuance is negative. The average equity ratio of 7% is larger than the 4.8% in Kashyap and Stein (1995), in line with the industry-wide capital build up that occurred in the decade before the subprime crisis (Flannery and Rangan, 2008). Banks issued equity in 66% of the firm-quarter observations in our sample. The net gain on actual securities sold averages 0.14% of equity, and for 68% of the observations in our sample, the realized gains are positive. The average (median) bank in our sample has a *Z* score of 89 (56). Finally, 11% and 4% of the bank quarters in our sample involve an acquisition or divestiture reported in SDC, respectively.

III. Results

A. Univariate Analysis

We begin with univariate tests on bank financial variables. Table III shows results for funding problems, asset sales, losses, and cherry picking during booms, all crises, and the most recent crisis. In this table, we compare crises to booms or the subprime crisis to booms. Asterisks indicate significant differences between the values in crises as compared to booms. Contrary to the liquidity debt shortfall hypothesis (H1A), crises do not typically involve a debt shortfall. By all measures, net debt growth is positive in a crisis. Table III also reports the fraction of banks that were unable to maintain debt funding in a crisis. Specifically, we create an indicator variable that is equal to one when the level of short-term debt in a crisis (boom) quarter is below its level in the quarter immediately prior to the crisis (boom). These results indicate that in a crisis, the majority of banks are able to maintain funding at or above precrisis levels. Notably, in the subprime crisis, the fraction of bank quarters in which funding falls from the earlier period does not differ significantly from that during booms.

However, net debt issuance is significantly lower in crises than in booms, and banks are more likely to have negative debt issuance in crises (43% and 41% in all crises and the subprime crisis, respectively, versus 36% in booms), which might reflect funding shocks for some banks during crises. Furthermore, during the subprime crisis, the average change in short-term debt is negative, which is consistent with H1A.

Table III shows that deposit growth is fairly stable over the business cycle, although during the recent crisis deposit growth is significantly lower than during booms. Since deposits and debt are the largest sources of funding for banks, and both continue to grow in crises, even in the recent crisis, the univariate evidence does not support the prediction of H2A that banks will be forced to sell assets. Table III also reveals that during all crises, equity issuance is not uncommon and equity ratios tend to increase, supporting H2B. However, an exception is the most recent crisis, which has an average equity ratio decline of 0.15% and during which the majority of the banks experience equity ratio declines (67%).

H2A predicts that assets will decline in a crisis due to forced sales, but Table III indicates positive asset growth in crises, albeit at a slower pace than in booms. Strikingly, average asset growth during the subprime crisis does not differ significantly from asset growth during booms. Loans, the largest asset category, also experience slower growth during crises, but the growth remains positive and economically large. As with H1A, a caveat of the univariate tests for H2A is that more banks report a decline in assets during crises (although not in the subprime crisis), which may also reflect funding problems for some institutions. However, the change in assets in Table III comprises both asset sales and write-downs, so the larger fraction of negative asset changes in a crisis may simply arise from widespread write-downs rather than sales. We use hand-collected data to separate the effect of asset sales and write-downs on the change in assets in later analyses. Note, in Figure 2, that part of the low asset growth in 2008 reflects write-downs of $11.3 billion, a result consistent with our conjecture.

We further analyze the liability management hypotheses (H2A and H2B) by examining government assistance and FHLB advances during the recent crisis. In Figure 1, we examine quarterly asset growth and net debt issuance during the most recent crisis and show how Fed and FHLB borrowing affected short-term debt. First, the figure indicates positive net debt issuance through Q3 2008. Thus, this quarter-by-quarter analysis of capital markets funding during the subprime crisis suggests that the crisis was not triggered by funding problems after a liquidity shock. Even in Q4 2008 when debt shortages appear more often, banks continue to experience positive asset

Table III. Funding and Asset Growth of Large Commercial Banks

The sample is composed of all of the banks covered by Compustat Quarterly Bank and Thrift data falling into the top 10% of all banks by asset size during at least one quarter during the sample period. Failed banks are included until the date of their failure (per FDIC website). Booms: All, Crises: All, and Crisis: 3/07-12/08 are defined in Table I. Net Debt Issuance, if not available on Compustat, is equal to the change in debt (short-term and long-term) in the current quarter. S-T Debt/Total Assets Decline Relative to Pre-Boom/Crisis Level Indicator is set equal to one if compared to the preboom/precrisis S-T Debt/Total Assets and the current quarter's S-T Debt/Total Assets is lower. Net Debt Issuance < 0 Indicator is equal to one if the net debt issuance is negative and zero otherwise. Net Short-Term (S-T) and Net Long-Term (L-T) Debt Issuance, if not available on Compustat, is equal to the change in short-term or long-term debt as reported in the current quarter. Deposit Change, if not available on Compustat, is equal to the change in net deposits from the end of prior quarter. Failed banks are excluded from the sample after the date of their failure per the FDIC website. Change in Equity Ratio is the quarterly change in shareholder equity scaled by total assets. Change in Equity Ratio < 0 is an indicator variable set equal to one if the equity ratio declines as compared to the prior quarter and zero otherwise. Issued Equity Indicator is based on net equity issuance calculated as sales minus the purchase of common and preferred stock. If the data on the sale and purchase of stock are not available, the net equity issuance is estimated as the change in shareholder equity less the change in retained earnings. Change in Assets is the quarterly asset growth rate. Change in Assets < 0 Indicator is equal to one if Change in Assets is negative and zero otherwise. Change in Loans is the quarterly change in loans net of allowances for total loan losses. Net Gain on Actual Sec. Sales is the net gain on actual securities sold and excludes write-downs of OTTI assets. The Net Gain on Actual Sec. Sales > 0 Indicator is set equal to one if the net gain is positive and zero otherwise. For the tests of differences in means/medians between "Boom: All" versus either "Crisis: All" or "Crisis: 3/07-12/08." Tests involving Net Gain on Actual Sec. Sales (Net Gain on Actual Sec. Sales > 0 Indicator) are based on differences from zero (0.5) and & indicates that only observations with nonzero data for a particular variable have been used. For all crises (3/2007-12/2008 crisis), the actual gains/losses on security sales are negative, zero, and positive for 932 (76), 500 (159), and 1,660 (208) observations, respectively.

		Boom: All ($N = 2,277$)	Crisis: All ($N = 3,092$)	Crisis: 3/07-12/08 ($N = 443$)
Net Debt Issuance/ Lag(Total Assets)	*Ave*	1.02%	0.46%***	0.54%**
	Med	0.62%	0.30%***	0.38%**
S-T Debt/Total Assets Decline Relative to Pre-Boom/Crisis Level Indicator	*Ave*	37.81%	48.77%***	39.73%
Net Debt Issuance < 0 Indicator	*Ave*	35.62%	42.95%***	40.63%**
Net S-T Debt Issuance/ Lag(Total Assets)	*Ave*	0.47%	0.27%**	−0.02%**
	Med	0.15%	0.06%**	0.00%***
Net L-T Debt Issuance/Lag(Total Assets)	*Ave*	0.54%	0.19%***	0.57%
	Med	0.02%	0.00%***	0.07%
Deposit Change/Lag(Total Assets)	*Ave*	2.21%	1.92%	0.99%***
	Med	0.92%	0.93%	0.67%***
Change in Equity Ratio	*Ave*	0.00%	0.01%	−0.15%**
	Med	0.01%	0.03%**	−0.13%***
Change in Equity Ratio < 0	*Ave*	48.05%	45.05%**	67.27%***
Issued Equity Indicator	*Ave*	55.74%	72.22%***	53.94%

(*Continued*)

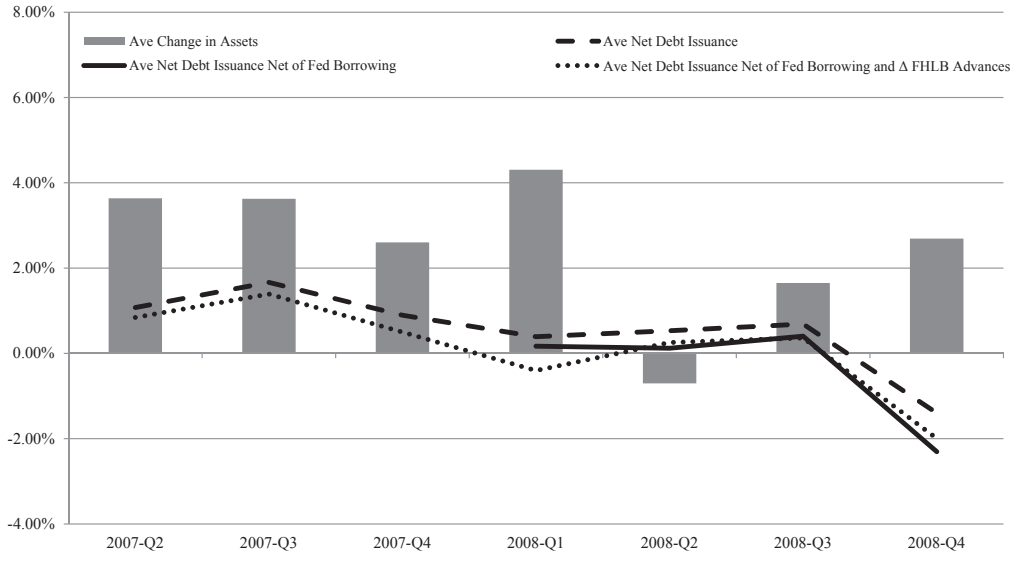
Table III. Funding and Asset Growth of Large Commercial Banks (*Continued*)

		Boom: All ($N = 2,277$)	Crisis: All ($N = 3,092$)	Crisis: 3/07-12/08 ($N = 443$)
Change in Assets	*Ave*	3.70%	2.90%***	3.17%
	Med	1.93%	1.69%***	1.66%**
Change in Assets < 0 Indicator	*Ave*	26.04%	30.76%***	28.67%
Change in Loans/Lag(Total Assets)	*Ave*	2.43%	1.43%***	1.70%**
	Med	1.40%	0.85%***	1.11%***
Net Gain on Actual Sec. Sales/Lag(Sh. Equity)[&]	*Ave*	N/A	0.10%***	0.14%
	Med	N/A	0.01%***	0.03%***
Net Gain on Actual Sec. Sales[&] > 0 Indicator	*Ave*	N/A	64.03%***	73.24%***

***Significant at the 0.01 level.
**Significant at the 0.05 level.
*Significant at the 0.10 level.

Figure 1. Quarterly Change in Total Assets and Net Debt Issuance: Q2 2007-Q4 2008

This figure reports the average quarterly change in assets including net debt issuance (total, as well as net borrowing, from the Fed and the FHLB) from Q2 2007-Q4 2008. The sample and the variables are defined in Tables II and III. Fed borrowing is borrowing from the Fed's liquidity facilities made available under the FOIA petition. Δ FHLB advances is the quarterly change in advances as reported by FHLBB for the top 10 banks.



growth. Indeed, the only quarter with negative asset growth is Q2 2008, a quarter with positive net debt issuance. These patterns are inconsistent with a liquidity-based explanation of the subprime crisis. Further, funds provided by the Fed and the FHLB in the crisis were relatively small.[4] Banks also appear to strategically switch between FHLB advances and borrowing from the Fed during Q2 through Q4 of 2008. Our results are consistent with He et al. (2010) who find that commercial banks had sufficient access to liquidity during the subprime crisis and did not fully tap all of the sources of debt financing available to them. We reach similar conclusions for other crises in our sample (not shown). Specifically, on average, banks continue to grow during every quarter throughout the crises in our sample. The positive asset growth during the recent crisis may be related to banks' off balance sheet conduits, as argued by Acharya, Schnabl, and Suarez (2013) and Covitz, Liang, and Suarez (2013). This may also explain the decline in equity capital (not shown) of roughly 15 and 33 basis points in Q3 and Q4 of 2008, respectively. Still, bringing such conduits back on the balance sheet is not consistent with forced asset sales arising from debt shortfalls.[5]

H3B states that banks will avoid fire sales in crises by cherry picking (favoring sales of assets with high market values relative to their stated book values). We investigate this hypothesis with data from SEC filings on gains and losses on sales. Prior to 1993, the investment securities gain or loss account on the income statement included only gains or losses from the actual sales of securities. Since 1993, this account includes gains and losses from sales and write-downs of "available for sale" securities that are considered "other than temporarily impaired" (OTTI), obscuring the extent of fire sales in the data.[6] Thus, to properly identify gains and losses on the actual sales of securities during crises, we manually review footnotes in 10-K reports during crisis periods since 1993. In Figure 2, we examine the aggregate evidence related to net gains on securities sales for the periods for which we have hand-collected data, including detailed data for each year in the last crisis. The results indicate that gains on sales of securities are more common than losses, since the net aggregate amount is positive in all four periods shown in the graph. Not only does Figure 2 suggest substantial cherry picking and few fire sales during the recent crisis, but it also indicates that fire sales (net losses) were a smaller issue in the last crisis as compared to the previous two. The results are also consistent with a strategy of cherry picking when regulatory capital constraints are binding, since the gains are nearly perfectly matched by write-downs in the last crisis. Banks report about $1.6 billion of OTTI write-downs and approximately $1.9 billion of gains on actual sales in 2007. In addition to investment security sales, we also examine banks' SEC filings for sales of other assets in 2007-2008. Examples of these other sales include bank branch sales and divestitures of subsidiaries. In aggregate, realized gains from sales of other assets total $3.0 billion in 2007. The results for 2008 are even more extreme. The banks report, in

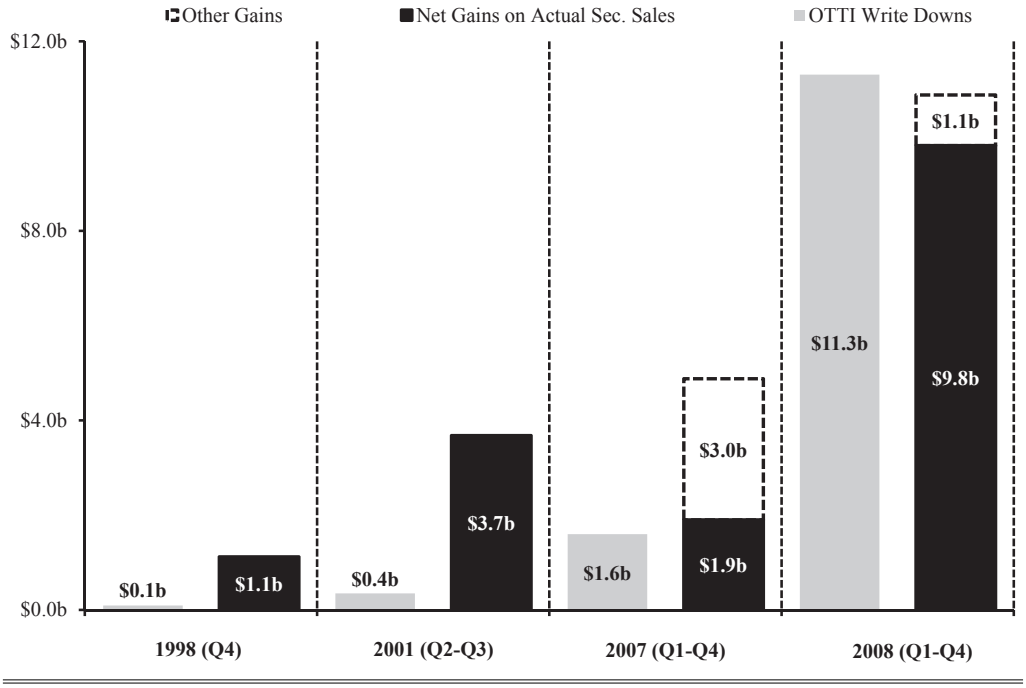
[4] We note that Fed borrowing was unusually high in Q3 2008 due to discount window borrowing by Wachovia as part of its takeover by Wells Fargo. Thus, the typical amount of borrowing was even smaller than suggested by the graph. Further, the data indicate that the majority of discount window borrowing during 2008 was by foreign banks, such as Dexia, Depfa, Fortis, and the Bank of Scotland. See Boyson et al. (2013b) for details.

[5] Two other government programs that were started during our sample period, the Capital Purchase Program (CPP) and the Treasury Loan Guarantee Program (TLGP), mainly added liquidity in late December 2008 and did not affect Q4 2008 balance sheets. Still, we investigate SEC filings of our banks in Q4 2008 and find that these firms received $176 billion through the CPP, including $11 billion received by PNC and Fifth Third on New Year's Eve 2008 that was unlikely to have increased their Q4 lending. Indeed, lending among the banks receiving these funds fell by $40 billion in the last quarter of 2008. The banks received another $77 billion through the TLGP, nearly all of which came in December. Again, lending at commercial banks that received TLGP assistance fell in Q4 2008.

[6] Since 1993, FASB 115 has required that banks adjust their earnings to reflect market value changes in their investment securities that are classified as "available-for-sale." If an unrealized loss in this asset category is considered permanent, it is recorded on the income statement as if it were a realized loss. By contrast, very few loans are marked to market.

Figure 2. Write Downs, Gains on Actual Securities Sales, and Other Gains Reported by Commercial Banks in Crises

This figure provides the aggregate amount of write downs, net gains on actual securities sales, and other gains during the last three crises for the banks in our sample. The sample and variables are defined in Tables II and III. Other Gains are reported for 2007 and 2008 only.



aggregate, $11.3 billion in OTTI write-downs and $9.8 billion in gains on sales. Furthermore, we identify aggregate gains from sales of other assets of $1.1 billion in 2008, again providing strong evidence that in times of crises banks cherry pick assets to boost reported equity. Essentially, the strategy of cherry picking drives the main components of the investment gains/losses variable from 2007 to 2008.[7] These results are contrary to H3A and consistent with H3B.

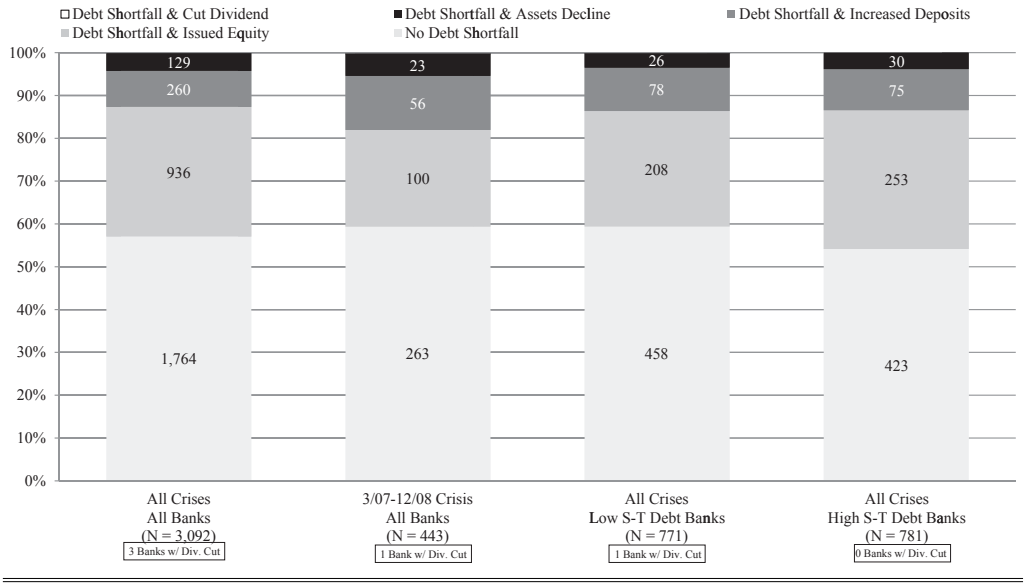
Table III also provides evidence regarding fire sales. In particular, gains and losses on sales of assets net of write-downs suggest that most asset sales raise enough funds to pay off the debt associated with the divested assets, which is counter to H3A. Not only do asset sales primarily result in positive realized gains in crises, but also the fraction of asset sales with gains is statistically greater during the subprime crisis (about 73% for the subprime crisis vs. 64% in other crises).

Since some banks may be less exposed to problems in wholesale funding markets because of their liability structures, we consider how banks in the most extreme quartiles of short-term debt to total assets respond to debt shortfalls. In Figure 3, we analyze how often banks use each of four alternatives: 1) new deposits, 2) net equity issuance, 3) dividend cuts, and 4) asset sales.

[7] Consistent with our findings for periods prior to the subprime crisis, Badertscher, Burks, and Easton (2011) report aggregate OTTI charges for the top 100 banks of less than $0.2 billion quarterly from 2004 to 2008.

Figure 3. Frequency of Actions Taken by Commercial Banks during Crises

This figure illustrates the fraction and the number of banks in our sample during all crises experiencing no debt shortfall and those banks experiencing debt shortfalls, as well as equity issuances, an increase in deposits, asset decline, and dividend cuts. Each bank is counted only once based on the overall frequency of an action taken by all of the banks in the sample. Debt shortfall occurs when a bank's net debt issuance is negative. Crises are defined in Table I. The sample and variables are defined in Tables II and III.

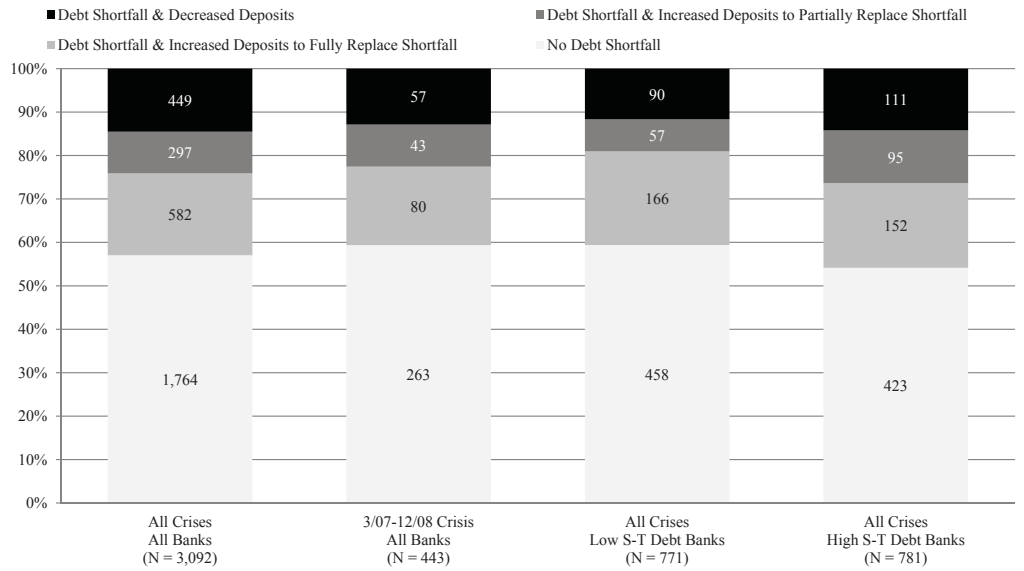


The results indicate that the most frequently used strategy for replacing lost funding in a crisis is equity issuance followed by increasing deposits. For the 1,325 observations (out of 3,092) that face such shortfalls, banks issue equity to offset the funding loss more than 70% of the time. In results not shown, we find that even undercapitalized banks (those in the bottom quartile of capital) manage to issue equity. Among the banks that do not issue equity, the next most popular approach is to increase deposits. Even banks that rely heavily on short-term debt increase deposits more often than shrinking their balance sheets, which suggests that the costs of these alternatives are not onerous. In contrast, fewer than 10% of bank quarters with debt shortfalls also have asset declines (129 of 1,325) and, as noted earlier, these asset declines include both write-downs and cherry picking. Figure 3 also demonstrates how frequently these alternatives are used in the recent crisis. Although equity issuance is not as popular as in other crises, deposits and asset sales are used to replace debt more often. Few banks with debt shortfalls cut their dividends during a crisis.

In Figure 4, we examine how much of the lost funding was replaced by the most favored alternative in terms of dollars raised. While Figure 3 reports that equity issuance is the most common tool for dealing with debt shortfalls in crises, deposits and asset sales account for the two highest dollar amounts raised at these banks. Figure 4 shows that in about 44% of the cases with debt funding shortages (582 of 1,325), banks solve the problem entirely with new deposits. In another 297 instances (22% of the time), banks respond to the shortfall by replacing, on average, half of their lost funds with deposits, resorting to asset shrinkage for most of the rest. Thus,

Figure 4. Fraction of Commercial Banks during Crises Partitioned by Debt Shortfall and Change in Deposits

This figure presents the fraction and the number of banks in our sample during all crises experiencing no debt shortfall and those banks experiencing debt shortfalls, where the debt shortfall is fully (partially) offset by an increase in deposits, as well as banks experiencing debt shortfalls and a decrease in deposits. Debt shortfall occurs when a bank's net debt issuance is negative. Crises are defined in Table I. The sample and variables are defined in Tables II and III.



two-thirds of banks experiencing debt shortfalls replace at least half of their shortfalls with new deposits. This reliance on deposits also holds in the most recent crisis.

Only about one-third of the banks that face a debt shortfall (449 observations) also experience declines in deposits. As we noted above, asset sales are the second most heavily used strategy to deal with debt shortfall in terms of dollars raised. Hence, banks facing debt shortfalls and deposit declines sell assets, which is suggestive of exogenous liquidity shocks. Consistent with the prediction of H2A, the proportion of banks experiencing funding shortfalls and deposit declines is higher at banks with more short-term debt. However, the difference is modest (31% vs. 29%). Furthermore, some of these asset sales may not be at fire sale prices and may instead reflect cherry picking.

Overall, the univariate results are inconsistent with the first three liquidity hypotheses, and therefore, do not support H4A either. The evidence is instead more often consistent with the insolvency explanation of crises.

B. Regression Analyses

The dependent variables in Table IV are net debt issuance [Models (1)-(4)], the percentage change in total assets [Models (5)-(8)], and the change in the equity ratio [Models (9)-(12)]. We control for acquisitions and divestitures during the quarter and for bank size. We do not include

Table IV. OLS Regression Analysis of Quarterly Net Debt Issuance, Change in Equity Ratio, and Change in Total Assets during Crises and Booms

The sample is composed of all of the banks covered by Compustat Quarterly Bank and Thrift data falling into the top 10% of all banks by asset size during at least one quarter during the sample period. Failed banks are included until the date of their failure (per FDIC website). Crisis Indicator is equal to one if the quarter falls into a crisis period listed in Table I and zero otherwise. Low/High Short-Term (S-T) Debt and Equity, S-T Debt/Assets, Equity Ratio, A-1 Rating Indicator, *Z* Score, and Assets are measured based on the quarter immediately preceding the beginning of a boom or crisis. Low/high indicator variables are equal to one if the bank falls in the lowest/highest quartile of the in-sample distribution of the relevant variable during a quarter preceding the crisis/boom and zero otherwise. All remaining variables are defined in Tables II and III. Heteroskedasticity-consistent standard errors clustered at the bank level are used.

	Net Debt Issuance				% Change Total Assets				Change in Equity Ratio			
	1	2	3	4	5	6	7	8	9	10	11	12
Intercept	0.967***	1.463***	1.035***	1.066***	3.003***	4.039***	3.091***	3.167***	0.018	0.232***	0.003	0.046**
Crisis Indicator	−0.486***	−1.639***	−0.654***	−0.710***	−0.492	−3.404***	−0.899*	−0.487	−0.019	0.053	−0.002	−0.017
Low S-T Debt Indicator	0.160		0.011		0.430		−0.377		0.022		0.031	
High S-T Debt Indicator	−0.236		−0.251		−0.560		−0.577		−0.012		−0.007	
S-T Debt/Total Assets		−1.129		−0.726		−3.055		−0.704		−0.279**		−0.147
Low Equity Ratio Indicator	0.357				0.659				0.026			
High Equity Ratio Indicator	−0.089				0.104				−0.070***			
Equity Ratio		−3.944				−6.123				−2.601***		
A-1 Rating Indicator		−0.175				−0.403				0.012		
Low *Z* score Indicator			0.194				0.954				0.028	
High *Z* score Indicator			−0.299**				−0.669				−0.025	
Z Score				−0.077				−0.290				−0.034***
Crisis(t) X:												
Low S-T Debt Indicator	0.048		0.197		0.616		1.640**		0.023		0.011	
High S-T Debt Indicator	0.285		0.343		0.650		0.723		0.015		0.015	
S-T Debt/Total Assets		2.172		1.509		2.134		−2.578		−0.090		0.113
Low Equity Ratio Indicator	−0.642**				−1.991***				0.061**			
High Equity Ratio Indicator	0.001				0.148				0.033			
Equity Ratio		12.27**				38.59***				−1.054		
A-1 Rating Indicator		0.133				0.267				0.020		
Low Z score Indicator			−0.080				−0.987				0.011	
High *Z* score Indicator			0.378*				0.899				0.010	
Z Score				0.137				0.555*				0.028**

(*Continued*)

Table IV. OLS Regression Analysis of Quarterly Net Debt Issuance, Change in Equity Ratio, and Change in Total Assets during Crises and Booms *(Continued)*

	Net Debt Issuance				% Change Total Assets				Change in Equity Ratio			
	1	2	3	4	5	6	7	8	9	10	11	12
Acquisition Indicator	0.131	0.101	0.114	0.112	3.420***	3.357***	3.217***	3.216***	−0.020	−0.016	0.006	0.003
SDC Divestiture Indicator	0.028	0.007	0.033	0.034	0.030	−0.062	0.069	0.074	0.059*	0.064*	0.053	0.048
Assets (millions)	−0.067	−0.073	−0.170	−0.134	1.143*	0.856	0.709	0.830	−0.184***	−0.179***	−0.155***	−0.149***
Adjusted R^2	0.009	0.008	0.007	0.005	0.018	0.017	0.016	0.013	0.007	0.013	0.004	0.003
Observations	5,369	5,369	4,993	4,993	5,369	5,369	4,993	4,993	5,369	5,369	4,993	4,993

***Significant at the 0.01 level.
**Significant at the 0.05 level.
*Significant at the 0.10 level.

variables related to the macroeconomy since inclusion of these variables would weaken the results for both explanations of crises if the macro variables are correlated with bank-specific quarterly characteristics. Furthermore, while we focus our analysis on variables exogenous to the crisis or boom periods, in unreported results, we note that the inclusion of bank-specific characteristics does not affect our conclusions. All regressions use heteroskedastic standard errors clustered at the bank level.

Models (1)-(4) indicate that net debt issuance is significantly lower during crises, but, as the sum of the intercept and the coefficient indicator typically shows, it remains positive, ceteris paribus. Banks with significant short-term debt are no less likely to suffer a debt shortfall during crises than other banks, as the coefficients on the interaction of the crisis variable and the short-term debt variables are not different from zero in any of the models. Thus, liquidity shocks do not appear to disrupt funding during crises, rejecting H1A. Net debt issuance in a crisis is more closely related to a bank's credit cushion, as measures of solvency interacted with the crisis variable are significant with the correct signs. That is, negative for the low equity ratio indicator, positive for its continuous counterpart, and positive for the *Z* score in three of the four specifications, supporting H1B.[8]

We test hypotheses H2A and H2B in Models (5)-(8). Recall that the dependent variable (change in assets) is affected by write-downs as well as sales. While this makes its interpretation more difficult, all four specifications are consistent with the univariate results that show positive asset growth during crises. All of the models report a decline in asset growth in a crisis, but the coefficient on the crisis indicator is only significant in Models (6) and (7), and the net effect of the intercept and the crisis indicator is always positive. The coefficient on the interaction of the crisis indicator and the indicator for low short-term debt is significantly positive in Model (7). This is the only coefficient that supports H2A in the four regressions.

In contrast, Models (5)-(8) provide evidence consistent with H2B. Models (5) and (6) indicate that undercapitalized banks shrink in a crisis, implying that they cannot manage the decline in debt issuance with other methods. The prior univariate evidence suggests that most of this shrinkage comes from write-downs and asset sales that generate gains (and increase capital). The positive and significant coefficient on the *Z* score interacted with the crisis variable in Model (8) also points to a role for solvency concerns, rather than reliance on short-term debt.

Finally, Models (9)-(12) examine changes in equity ratios. H4A predicts that liquidity shocks during crises will lead to fire sales, and thus a decline in equity for banks most reliant on capital markets. However, if shocks to fundamentals are important during crises (H4B), banks with the worst debt overhang problems (i.e., those with low precrisis equity) should suffer most. Consistent with our univariate results, Table IV provides no evidence that reliance on capital market funding hurts equity in a crisis, since none of the coefficients on short-term debt interactions are significant. In contrast, banks with low equity ratios prior to the crisis are more likely to increase equity during a crisis, supporting the idea that they cherry pick assets to generate equity ratio increases. However, the coefficient on the *Z* score interacted with the crisis indicator

[8] In unreported results, we assess the impact of the composition of a bank's loan portfolio. For example, if solvency concerns limit access to debt financing, then borrowing by banks with a large fraction of real estate loans in the last crisis should have fallen. We collect information on precrisis exposures to real estate (mortgage loans from Compustat), as well as data on the extent of precrisis loans to commercial and industrial (C&I) firms (from FYR-9C data). We note that C&I loans tended to perform well during the crises in our sample. Although the data are not available for the entire sample, the coefficient on the precrisis real estate (C&I) exposure is significantly negative (positive), indicating that the creditworthiness of the loan portfolio affected banks' ability to roll over debt. Therefore, our prior conclusions are further supported when considering the bank's loan composition. We also consider the bank's distance to default (Merton, 1974). The effect of the distance to default measure on net debt issuance is insignificant.

in Model (12) implies that the equity ratios of banks with low precrisis *Z* scores decline during crises. Both the *Z* score and its interaction with the crisis indicator are significant, have opposite signs, and are of similar magnitude. To understand how the *Z* score affects changes in equity in a crisis, we sum the two coefficients. The result is that in a crisis, bank equity changes are unrelated to *Z* scores (the sum is essentially zero). This finding may reflect the different strategies well-capitalized banks use to avoid fire sales, since it implies that healthier banks are more likely to lever up in booms, but not in crises. We consider this in further detail in Table V. In Models (9) and (10), the coefficient on divestitures suggests that banks increase equity by selling noncore assets, consistent with a key role for cherry picking and supportive of H3B and H4B. Finally, the largest banks experienced large declines in their equity ratios in crises.

In Table V, we analyze the net gains on actual asset sales (scaled by lagged assets) to test the fire sale hypotheses (H3). For periods after 1993, the gain/loss on sale account includes gains and losses on actual sales, as well as write-downs of OTTI assets. To identify actual sales, we review annual and quarterly reports (10-Qs and 10-Ks) for the crisis periods and subtract write-downs. As illustrated in Figure 2, there are very few OTTI write-downs during the 1998 and 2001 crises. The first four specifications in Table V are for all crises, while the next three are for the subprime crisis.

The high and low short-term debt indicator variables, short-term debt over total assets, the net debt issuance indicator, and its interaction with short-term debt over total assets are included in Table V to test the liquidity fire sale hypothesis (H3A). Under H3A, the coefficients on these five variables should reveal a greater tendency for fire sales (net realized losses) at banks with funding shortages. The liquidity shock theories predict that banks with exposure to frozen debt markets (high short-term debt indicator equal to one) and those with recorded debt shortages (net debt issuance <0 indicator equal to one) will be forced to sell assets at a loss (i.e., the dependent variable will have a negative value).

None of the seven models indicate that the fraction of short-term debt significantly affects realized losses on asset sales, contradicting H3A. Indeed, there is no evidence in Table V to indicate that fire sales are related to banks' reliance on short-term debt or funding shortages. Consistent with Figure 2, the intercept in the base Model (1) is significantly positive, implying that, on average, banks do not typically report realized losses.

Hypothesis H3B states that if banks lack funding alternatives and resort to asset sales, they will cherry pick to increase reported capital. We test this hypothesis by including two new indicator variables to capture the most common ways to replace lost funding (raising deposits and issuing equity). If H3B is true, the coefficients on these two variables will be significantly negative. That is, banks with alternative sources of funds will sell assets less often and account for less of the widespread cherry picking that we have previously documented in Figure 2. Consistent with H3B, results in Models (2)-(4) indicate that banks with deposit increases realize lower gains on asset sales. We find no significant relationship between equity issuance and gains from securities sold. Neither of these variables is significant in the recent crisis [Models (5)-(7)].[9]

Models (2)-(7) also include an indicator variable for banks that divest business units (based on SDC data). The SDC divestiture indicator has a significant and positive coefficient in Models

[9] In untabulated results, we assess whether the composition of a bank's loan portfolio and the degree of concentration in the portfolio affect our results. The coefficient on the fraction of precrisis real estate loans is positive and significant, which is consistent with cherry picking by banks with high exposure to real estate. The precrisis loan concentration, measured by a Herfindahl index of loans, enters with a positive and significant coefficient as well, indicating that banks with concentrated loan portfolios are more likely to cherry pick. These results are generally consistent with H3B. Finally, we note that the Merton distance to default measure is not significant.

Table V. Regression Analysis of Quarterly Actual Gains/Losses on Security Sales Scaled by Lagged Total Assets during Crises

The sample is composed of all of the banks covered by Compustat Quarterly Bank and Thrift data falling into the top 10% of all banks by asset size during at least one quarter during the sample period. Failed banks are included until the date of their failure (per FDIC website). For all crises (3/2007-12/2008 crisis), the actual gains/losses on security sales are negative, zero, and positive for 932 (76), 500 (159), and 1,660 (208) observations, respectively. Low/High Short-Term (S-T) Debt and Equity, S-T Debt/Assets, Equity Ratio, A-1 Rating Indicator, *Z* Score, and Assets are measured based on the quarter immediately preceding the beginning of a crisis. Low/High indicator variables are equal to one if the bank falls in the lowest/highest quartile of the in-sample distribution of the relevant variable during a quarter preceding the crisis and zero otherwise. Increased Deposits Indicator is equal to one if, during the quarter, the deposits declined and zero otherwise. All remaining variables are defined in Tables II and III. The dependent variable is scaled by 100. Heteroskedasticity-consistent standard errors clustered at the bank level are used.

	All Crises				3/2007-12/2008 Crisis		
	1	2	3	4	5	6	7
Intercept	0.677***	0.804***	−1.220*	0.732*	2.188***	0.676	0.504
Low S-T Debt Indicator	−0.074	0.011			−1.679		
High S-T Debt Indicator	0.302	0.308			−0.498		
S-T Debt/Total Assets			2.105	0.992		5.992	4.407
Net Debt Issuance < 0 Indicator			0.308			−0.496	
Net Debt Issuance < 0 Indicator × S-T Debt/Total Assets			−0.335			−3.360	
Increased Deposits Indicator		−0.585**	−0.615***	−0.575**	0.247	0.140	0.148
Issued Equity Indicator		0.243	0.203	0.259	−0.741	−0.625	−0.749
SDC Divestiture Indicator		1.844***	1.540**	1.878***	1.798	1.956	1.700
Low Equity Ratio Indicator	−0.562*	−0.576**			−1.681**		
High Equity Ratio Indicator	−0.275	−0.258			−1.375*		
Equity Ratio			19.266***			−3.567	
A-1 Rating Indicator			1.317***			2.228**	
Z Score				−0.202*			0.243
Acquisition Indicator	0.433	0.462	0.264	0.522*	0.577	0.856	0.891
Assets (millions)	0.415	0.302	−0.437	0.133	−0.234	−1.857**	−0.623
Adjusted R^2	0.003	0.010	0.026	0.010	0.022	0.023	0.008
Observations	3,092	3,092	3,092	2,955	443	443	439

***Significant at the 0.01 level.
**Significant at the 0.05 level.
*Significant at the 0.10 level.

(2)-(4). This result implies that sales of business units in a crisis usually help bolster equity rather than deplete it via fire sales.

According to H3B, banks that start the crisis with the least amount of capital are most likely to sell assets at a gain because cherry picking raises reported capital. The results for the solvency variables (low/high equity ratio indicators, equity ratio, A-1 rating indicator, and *Z* score) in

Models (1)-(7) are mixed. The significant negative coefficients on *Z* score and on the high equity indicator in Models (3) and (5) suggest that less solvent banks do more cherry picking. However, the significant negative coefficient on the indicator variable for low equity in Models (1), (2), and (5), the significant positive coefficient on the equity ratio in Model (3), and the significant positive coefficient on the A-1 rating indicator in Models (3) and (6) imply that better capitalized banks realize more gains. These results may reflect better opportunities for cherry picking at healthier banks. Although some evidence as to which banks cherry pick the most contradicts H3B, we note that the coefficient on the low equity indicator is always smaller than the intercept. This means that the predicted values of the dependent variable remain positive for undercapitalized banks. They also cherry pick, but less so than banks with medium or high equity. We note that untabulated univariate results indicate that low equity banks are much less likely to report gains on sales than other banks, as the regression coefficients suggest. However, low equity banks are also the least likely to report losses on sales (i.e., they have fewer sales and, as such, more zeroes in the dependent variable vector).

Overall, we find limited evidence to suggest that illiquidity in capital markets drives commercial banks into financial distress in crises. In our multivariate analysis, the coefficients on short-term debt-related variables are insignificant. Our results are more often consistent with bank creditworthiness as an important factor in financial crises.

IV. Sensitivity Analyses

We perform several robustness tests in this section including: 1) the definition of crisis periods, 2) whether liquidity problems occur early in a crisis and are supplanted by solvency problems in later quarters, 3) whether tests are more likely to reject hypotheses because only some crises were triggered by liquidity shocks, 4) the definition of bank reliance on capital markets, 5) the econometric reliability of the Table V analysis, 6) whether the period surrounding the bankruptcy of Lehman in late 2008 provides consistent results, and 7) whether including banks that do not use much short-term debt in our sample affects our conclusions.

A. Definition of Crisis Periods

We examine whether the definition of crisis periods affects our results. In unreported tests, we find that trimming our crisis periods by one quarter at the start and one quarter at the end does not materially alter our results. We draw further support for the definition of crisis periods by comparing the variables we use for potential liquidity shocks to those in Boyson, Stahel, and Stulz (2010). They construct a sample of liquidity shock periods by identifying months that fall into the top or bottom quartile of various liquidity measures. We find that at least one of their liquidity measures implies a shock during each month of the subprime crisis as we define it.

We also investigate bank funding and asset sales after Q4 2008 (the last quarter in our sample period). Since many government liquidity programs were enacted in early 2009, our results could become weaker when we include these periods. We separately examine the last two quarters of the subprime crisis (i.e., the first two quarters of 2009) to determine whether programs such as TLGP and CPP mitigated the effects of funding shortfalls.[10] If greater government intervention helps resolve funding crises, we should observe increased debt issuance, increased lending activity,

[10] Note that National Bureau of Economic Research marks the end of the last recession as June 2009. Refer back to Footnote 5 for details on CPP and TLGP.

higher asset growth, and fewer fire sales during the first two quarters of 2009. In untabulated analysis, we find that the first half of 2009 had slower debt issuance and lower asset growth, suggesting that government programs had little effect on these factors. This result is consistent with our main finding that solvency played an important role in this crisis. Many banks increased capital ratios in 2009 by shrinking. This strategy of retrenchment also appears in significantly negative loan growth during early 2009. Turning to asset sales, we find increased cherry picking in the first two quarters of 2009. Over 90% of banks involved in asset sales during this period book gains on their sales. This result is even higher than for the period ending in December 2008, which is, in turn, significantly higher than in most crises. Furthermore, banks' equity ratios significantly improve in 2009 even though equity issuance is comparable between the two periods, reflecting gains on asset sales.

B. Timing of Liquidity Shocks during Crises

In addition to adjusting the starting and ending quarters of our crisis periods, we examine the quarters in the middle of the crises to see whether liquidity problems appear at some other point during a crisis. We calculate the fraction of banks that experience both net debt shortfalls and deposit runoffs during a crisis quarter and use this fraction to indicate periods when capital markets are illiquid. While the (untabulated) results indicate that the first quarter of a crisis is typically followed by a quarter with fewer banks that lose debt funding and deposits, this variable rises and falls in a seemingly random pattern throughout the crises.

C. Crises Characterized as Credit Crunches

Another robustness check considers whether some of the crises we study are not caused by liquidity shocks. If only some of the prior crises are caused by liquidity shocks, then testing liquidity shock theories on all of the crises may not find support for these theories. Thus, we examine only those crises characterized by Bordo and Haubrich (2010) as credit crunches: 12/1988-12/1992, 8/1998- 1/1999, and 3/2007-12/2008. In untabulated results, we find results for net debt issuance, asset changes, and equity ratio changes that are consistent with our prior conclusions regarding the importance of solvency rather than liquidity.

D. Alternative Measures of Reliance on Capital Markets

Next, we assess the robustness of our measures of reliance on capital markets funding by defining two sets of alternative variables. First, we calculate the ratio of short-term debt to the sum of deposits, long-term, and short-term debt. Second, we calculate the ratio of deposits to total assets. Consistent with our prior approach, we also define indicator variables capturing whether a bank falls into the low/high quartiles of these ratios. We then estimate the regressions in Tables IV and V using these alternative measures. In unreported results, we note that the significance of the capital market reliance variables is not affected. Thus, our conclusions are not sensitive to the specific definition of banks' reliance on capital markets.

E. Quantile Regressions Analyzing Fire Sales

In Table V, approximately 30% of the bank quarter observations in crises have negative net gains, while most (54%) have positive gains. However, approximately 15% of the banks do not report any net gains (either because the net gain is zero or no asset sales take place). Therefore, ordinary least square (OLS) might not be appropriate. As such, as a robustness test, we use a

quantile regression analysis. The untabulated results indicate that banks that rely on short-term debt funding cherry pick assets in order to book a gain upon a sale. Specifically, reliance on short-term debt funding does not reliably affect the profitability of asset sales for quantiles for which banks report negative net gains, while the relation between the precrisis level of short-term debt is positive and significant for quantiles with positive net gains. The interaction of the net debt shortfall and the precrisis short-term debt level is insignificant in quantiles with net losses, further buttressing our conclusion that liquidity shocks do not lead to fire sales.

F. Lehman Bankruptcy

The period surrounding the bankruptcy of Lehman on September 15, 2008 is frequently characterized as a period when liquidity evaporated. In untabulated results, we investigate banks' debt issuance during the third and fourth quarters of 2008 in a regression using only data from the subprime crisis. To examine the effects of Lehman, we use two indicator variables, one each for Q3 and Q4 2008, and we interact these variables with the explanatory variables in Table IV. We note that the coefficient on the indicator for Q3 2008 is negative and insignificant in both specifications, suggesting that the Lehman bankruptcy did not lead to a substantial decline in debt funding for our sample banks during the last two weeks of Q3. The Q4 2008 indicator is significantly negative, but only when the precrisis equity ratio is not included in the regression. In contrast, variables related to creditworthiness are always significant, supporting H1B.

G. Short-Term Debt Reliance

We restrict our sample to the largest publicly traded banks to examine the effects of frozen capital markets on bank distress. However, even within our sample, it is possible that some banks are too small to access wholesale funding. As noted earlier, about 300 bank quarter observations have values of zero for the short-term debt/assets variable (which is measured before a crisis/boom period). If these observations represent banks that do not access the capital markets, our analysis may understate the effects of frozen capital markets. While it is important to have sufficient cross-sectional variation in the sample to assess the validity of the liquidity framework, we remove these observations from our sample to verify that our results are not driven by banks that do not access capital markets. In untabulated results, the significance levels of the test variables are generally unaffected and our conclusions hold. Therefore, including banks with low short-term debt reliance in our tests does not bias our findings. The majority of the 300 observations are quarters for banks that use short-term debt at some point, and more than one-third of them are banks that have positive short-term debt in at least one crisis.

V. Conclusion

In this paper, we consider two types of problems facing banks in a financial crisis: 1) liquidity and 2) solvency. We test these two explanations for financial crises by considering banks' financing choices and asset sales during crises. Our results indicate that funding problems are not strong enough to cause widespread declines in debt issuance among commercial banks. Nor do bank assets fall, on average, during these crises. While there are pockets of weakness, since the fraction of banks that suffer a drop in debt issuance and negative asset growth in a crisis is larger than in other times, we find no evidence that their problems owe to market-wide liquidity shocks. Rather, these pockets more often include banks that are closer to insolvency (those that started the crisis period with less capital).

Rather than liquidity shocks driving financial crises, we see greater evidence that problems at commercial banks emanate from the asset side of the balance sheet. Debt issuance is lowest among banks that enter the crisis with less capital. Asset growth typically reflects banks' efforts to regain regulatory compliance rather than forced sales at fire sale prices. Indeed, we see little evidence that sales of any kind occur in great numbers during a crisis, but those that do often involve cherry picking. In sum, our paper provides clear evidence that liquidity shocks are less important than shocks to fundamentals in explaining financial crises.

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