Bank Liquidity Creation

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Although the modern theory of financial intermediation portrays liquidity creation as an essential role of banks, comprehensive measures of bank liquidity creation do not exist. We construct four measures and apply them to data on virtually all U.S. banks from 1993 to 2003. We find that bank liquidity creation increased every year and exceeded $2.8 trillion in 2003. Large banks, multibank holding company members, retail banks, and recently merged banks created the most liquidity. Bank liquidity creation is positively correlated with bank value. Testing recent theories of the relationship between capital and liquidity creation, we find that the relationship is positive for large banks and negative for small banks. (*JEL* G21, G28, G32)

According to the modern theory of financial intermediation, banks exist because they perform two central roles in the economy—they create liquidity and they transform risk.[1] Analyses of banks' role in creating liquidity and thereby spurring economic growth have a long tradition, dating back to Adam Smith (1776).[2] Modern reincarnations of the idea that liquidity creation is central to banking appear most prominently in the formal analyses in Bryant (1980) and

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[1] These two roles are often jointly referred to as banks' qualitative asset transformation (QAT) function (e.g., Bhattacharya and Thakor 1993).

[2] Smith (book II, chapter II, 1776) highlights the importance of liquidity creation by banks and describes how it helped commerce in Scotland. In particular, he notes "That the trade and industry of Scotland, however, have increased very considerably during this period, and that the banks have contributed a good deal to this increase, cannot be doubted."

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Diamond and Dybvig (1983). These theories argue that banks create liquidity on the balance sheet by financing relatively illiquid assets with relatively liquid liabilities. Holmstrom and Tirole (1998) and Kashyap, Rajan, and Stein (2002) suggest that banks also create liquidity off the balance sheet through loan commitments and similar claims to liquid funds.[3]

Banks' role as risk transformers is also well studied. A vast literature has emerged on bank risk taking and prudential regulation, supervision, and market discipline to control risk-taking behavior. According to the risk transformation theories, banks transform risk by issuing riskless deposits to finance risky loans (e.g., Diamond 1984; Ramakrishnan and Thakor 1984; Boyd and Prescott 1986). Risk transformation may coincide with liquidity creation, as for example, when banks issue riskless liquid deposits to finance risky illiquid loans. However, liquidity creation and risk transformation do not move in perfect tandem—the amount of liquidity created may vary considerably for a given amount of risk transformed. It is therefore essential to study both roles of banks and to distinguish between them.

Most of the empirical literature has focused on banks' role as risk transformers, rather than on their role as liquidity creators. Consequently, comprehensive empirical measures of bank liquidity creation are conspicuously absent, making it difficult to address numerous questions of research and policy interest. How much liquidity does the banking sector create? How has bank liquidity creation changed over time? How does it vary in the cross section? Which banks create the most and least liquidity? What are the value implications of bank liquidity creation? Moreover, without measures of liquidity creation in hand, it is not possible to examine policy-relevant issues, such as the effect of bank capital on bank liquidity creation.

Our main goals here are threefold. Our first goal is to develop comprehensive measures of bank liquidity creation. We create four such measures that differ in how off-balance sheet activities are treated and how loans are classified. Our second goal is to use these measures to gain a deeper insight into banks' role as liquidity creators by addressing the questions highlighted above. Specifically, we explore how much liquidity banks create, how liquidity creation has changed over time, how it varies in the cross section, which banks create the most and least liquidity, and how liquidity creation is related to bank value. We do this by applying our liquidity creation measures to data on virtually all U.S. banks over 1993–2003, by splitting the data in various ways (by bank size, bank holding company status, wholesale versus retail orientation, and merger status), by contrasting the top 25% and bottom 25% of liquidity creators in each size class, and by examining correlations between liquidity creation and bank

[3] Other theoretical contributions explain the existence of bank loan commitments as providing a mechanism for optimal risk sharing (Campbell 1978; Ho and Saunders 1983), reducing credit rationing (James 1981; Blackwell and Santomero 1982; Morgan 1994; Thakor 2005), and ameliorating informational frictions between the borrower and bank (Berkovitch and Greenbaum 1991; Boot, Thakor, and Udell 1991; Boot, Greenbaum, and Thakor 1993). Melnik and Plaut (1986); Shockley and Thakor (1997); and Sufi (2007) provide detailed overviews of the contractual features of loan commitments and lines of credit.

value. The current financial crisis raises the additional question of how bank liquidity creation responds during crises. This is one of the issues addressed in a follow-up paper that uses one of the measures of liquidity creation developed here (Berger and Bouwman 2008). Our third goal is to use our liquidity creation measures to examine the policy-relevant issue mentioned above—the effect of bank capital on bank liquidity creation. Some recent theories predict that bank capital reduces bank liquidity creation, while others predict that capital makes banks capable of absorbing more risk, and thereby allows them to create more liquidity. We develop economic intuition about the types of banks for which these opposing effects may dominate, and test the relationship between capital and liquidity creation predicted by the theories.

To construct our liquidity creation measures, we use a three-step procedure. In step 1, we classify all bank assets, liabilities, equity, and off-balance sheet activities as liquid, semiliquid, or illiquid. We do this based on the ease, cost, and time for customers to obtain liquid funds from the bank, and the ease, cost, and time for banks to dispose of their obligations in order to meet these liquidity demands. Our use of just three liquidity classifications (liquid, semiliquid, and illiquid) is a necessary simplification—any finer distinctions would have to be made rather arbitrarily. In step 2, we assign weights to the activities classified in step 1. The weights are consistent with the theory—maximum (i.e., dollar-for-dollar) liquidity is created when illiquid assets are transformed into liquid liabilities and maximum liquidity is destroyed when liquid assets are transformed into illiquid liabilities or equity. In step 3, we construct four liquidity creation measures by combining the activities as classified in step 1 and as weighted in step 2 in different ways. The measures classify all activities other than loans by both product category and maturity but—due to data limitations—classify loans based either solely on category ("cat") or solely on maturity ("mat"). To assess how much liquidity banks create on the balance sheet versus off the balance sheet, we alternatively include off-balance sheet activities ("fat") or exclude them ("nonfat"). We thus construct liquidity creation measures based on the four combinations: "cat fat," "mat fat," "cat nonfat," and "mat nonfat." As explained below, "cat fat" is our preferred measure.

When we apply our measures to the data, we find that the U.S. banking industry created $2.843 trillion in liquidity in 2003 using our preferred "cat fat" measure.[4] This equals 39% of bank gross total assets or *GTA* (total assets plus allowance for loan and lease losses and the allocated transfer risk reserve) and is 4.56 times the overall level of bank equity capital, suggesting that the industry creates $4.56 of liquidity per $1 of capital. To provide further perspective on liquidity creation relative to bank size, note that bank liquidity creation equals 70% of gross loans and 58% of total deposits.

Liquidity creation has grown dramatically over time: it increased every year and virtually doubled between 1993 and 2003 based on our preferred "cat fat" measure. This evidence contradicts the notion that the role of banks in creating

[4] All liquidity creation measures in the article are as of December 31 of a given year.

liquidity has declined due to the development of capital markets. Our results are fairly similar when we calculate liquidity creation using our "mat fat" measure, which classifies loans based on maturity instead of category. Results based on our "nonfat" measures reveal that the banking sector only creates about half of its liquidity on the balance sheet, highlighting the importance of liquidity created off the balance sheet as in Holmstrom and Tirole (1998) and Kashyap, Rajan, and Stein (2002).

Liquidity creation differs considerably among large banks (*GTA* exceeding \$3 billion), medium banks (*GTA* \$1 billion–\$3 billion), and small banks (*GTA* up to \$1 billion) (measured in real 2003 dollars). We split our sample by bank size because size differences among banks are substantial and various empirical studies have shown that components of liquidity creation vary greatly by bank size. Based on our preferred "cat fat" measure, large banks are responsible for 81% of industry liquidity creation, while comprising only 2% of the sample observations. All size classes generate substantial portions of their liquidity off the balance sheet, but the fraction is much higher for large banks. All size classes increased liquidity creation in real terms over the sample period. While large banks showed the greatest growth in the dollar value of liquidity creation, small banks had the greatest growth in liquidity creation divided by *GTA*, equity, loans, and deposits.

Liquidity creation also varies with several key bank characteristics. It is starkly different for banks split by bank holding company status, wholesale versus retail orientation, and merger status. Based on our preferred "cat fat" measure, banks that are members of a multibank holding company, have a retail orientation, and engaged in M&A activity during the prior three years created most of the banking industry's overall liquidity. These banks also show the strongest growth in liquidity creation over time.

Liquidity creation is also positively linked with value. We examine the value implications of liquidity creation by focusing on listed independent banks and banks that are part of listed bank holding companies. We find that banks and bank holding companies that create more liquidity have significantly higher market-to-book and price-earnings ratios.

Turning to the theories on the relationship between bank capital and liquidity creation, some recent contributions suggest that bank capital may impede liquidity creation by making the bank's capital structure less fragile (e.g., Diamond and Rajan 2000, 2001). A fragile capital structure encourages the bank to commit to monitoring its borrowers, and hence allows it to extend loans. Additional equity capital makes it harder for the less-fragile bank to commit to monitoring, which in turn hampers the bank's ability to create liquidity. Capital may also reduce liquidity creation because it "crowds out" deposits (e.g., Gorton and Winton 2000). For expositional ease, we refer to this first set of theories jointly as the "financial fragility-crowding out" hypothesis.

An alternative view—related to banks' role as risk transformers—is that higher capital improves banks' ability to absorb risk and hence their ability to create liquidity. Liquidity creation exposes banks to risk—the greater the liquidity created, the greater are the likelihood and severity of losses associated with having to dispose of illiquid assets to meet customers' liquidity demands (Allen and Santomero 1998; Allen and Gale 2004). Capital absorbs risk and expands banks' risk-bearing capacity (e.g., Bhattacharya and Thakor 1993; Repullo 2004; Von Thadden 2004; Coval and Thakor 2005), so higher capital ratios may allow banks to create more liquidity. We refer to this second set of theories collectively as the "risk absorption" hypothesis, while recognizing that the theories together rather than separately produce this prediction.

Both the "financial fragility-crowding out" and the "risk absorption" effects may apply in differing degrees to liquidity creation by different banks, so the relevant empirical issue is discovering the circumstances under which each effect empirically dominates. We address this by testing whether the net effect of bank capital on liquidity creation is negative or positive for different sizes of banks. We expect that the "financial fragility-crowding out" effect is likely to be relatively strong for small banks. One reason is that small banks deal more with entrepreneurial-type small businesses, where the close monitoring highlighted in Diamond and Rajan (2000, 2001) is important. A second reason is that small banks tend to raise funds locally, so that capital may "crowd out" deposits as in Gorton and Winton (2000).[5] This effect is likely to be relatively weak for large banks that can more easily access funding from national or international capital markets. In contrast, the "risk absorption" effect is likely to be stronger for large banks because they are generally subject to greater regulatory scrutiny and market discipline than small banks, which may affect their capacity to absorb risk. Since medium banks fall somewhere in the middle, we expect that either effect may dominate for these banks or that these effects may simply offset each other.

While the theories suggest a causal relationship from capital to liquidity creation, in practice both may be jointly determined. This makes it challenging to establish causation. Although we present regression results using lagged capital to mitigate the endogeneity problem, we interpret our results with care and do not claim to have established causation. Nonetheless, at a minimum, the results should be viewed as interesting correlations between capital and liquidity creation that are consistent with the theories. We also address the endogeneity problem more directly with instrumental variable regressions and obtain consistent results.

Keeping these precautions in mind, we test the relationship between capital and liquidity creation by regressing the dollar amount of bank liquidity creation (calculated using our four measures and normalized by *GTA*) for each bank-year observation on the bank's lagged equity capital ratio and a number of

[5] Gorton and Winton (2000) develop a general equilibrium model, so it theoretically applies to all banks, small and large. However, we argue in Section 1.2 that as an empirical matter, it is likely to be more applicable to small banks.

control variables. Since the effect of capital on liquidity creation may be driven by banks' role as risk transformers rather than their role as liquidity creators, all our regressions control for bank risk. We use three-year lagged average values of capital and the other exogenous variables to mitigate potential endogeneity problems, as lagged values represent earlier bank decisions. We run the tests separately for large, medium, and small banks to allow for the possibility that capital may affect these banks differently.

We find empirical support for both hypotheses. For large banks, the relationship between capital and liquidity creation is positive, consistent with the expected empirical dominance of the "risk absorption" effect. In sharp contrast, for small banks, the relationship between capital and liquidity creation is negative, consistent with the expected dominance of the "financial fragility-crowding out" effect for these institutions. The relationship is not significant for medium banks, suggesting that the two effects cancel each other out for this size class. To understand more deeply why these differences exist, we also examine the relationship between capital and the individual components of liquidity creation and find substantial differences across size classes in which components are significantly correlated with capital.

We test the robustness of our main regression results in various ways. First, our main liquidity creation measures are based on the ease, cost, and time for customers to obtain liquid funds, and the ease, cost, and time for banks to dispose of obligations to provide liquid funds. Since buyers of loan commitments and letters of credit may not fully draw down committed funds, we construct an alternative measure that incorporates the likelihood with which these customers request actual funds. Second, we construct a liquidity creation measure that uses an alternative way to establish which assets are securitizable. Third, to address a potential concern that our dependent variable (liquidity creation) includes current equity capital with a weight of $-½$ while our key independent variable is the lagged equity capital ratio, we construct an alternative liquidity creation measure that does not include current capital. Fourth, since the theories sometimes use a broader definition of equity that includes other funds that cannot easily run on banks, we use an alternative capital ratio that includes equity plus other financial instruments, such as long-term subordinated debt (total capital specified in the Basel I capital standards). Fifth, because the intertemporal and cross-sectional liquidity creation patterns are so different for banks split by holding company status, wholesale versus retail orientation, and merger status, we rerun our regressions for these subsamples. The results of all of these robustness checks reinforce our main findings and suggest that the relationship between capital and liquidity creation is positive for large banks, insignificant for medium banks, and negative for small banks.

Since capital and liquidity creation may be jointly determined and the use of three-year lagged average values of capital may not be sufficient to mitigate such endogeneity concerns, we use an instrumental variable approach as our final robustness check. We select the effective state income tax rate and the fraction of seniors in the markets in which a bank operates as potentially valid instruments for lagged capital. Based on first-stage regression results, we use the tax rate as an instrument for large banks only and the fraction of seniors as an instrument for small banks only. Using these instruments, we find—consistent with our main findings—that the effect of capital on liquidity creation is significantly positive for large banks and significantly negative for small banks.

The remainder of the article is organized as follows. Section 1 reviews the literature. Section 2 describes the construction of our liquidity creation measures. Section 3 discusses our panel dataset of U.S. banks over 1993–2003, shows how bank liquidity creation varies over time and in the cross section, contrasts high and low liquidity creators, and explores the value implications of bank liquidity creation. Section 4 outlines our regression framework, and Section 5 contains our regression results. Section 6 addresses robustness issues, and Section 7 concludes.

1. Literature Review

In this section, we provide a brief review of the literature to place our article in context. Our research is related to three strands of literature: the measurement of bank liquidity creation; the theories of the effect of capital on liquidity creation; and the empirical studies of capital and liquidity creation. We discuss these three literatures in turn.

1.1 Measurement of bank liquidity creation

We are aware of only one paper that attempts to measure bank liquidity creation. Deep and Schaefer (2004) construct a measure of liquidity transformation and apply it to data on the two hundred largest U.S. banks from 1997 to 2001. They define the liquidity transformation gap or "LT gap" as (liquid liabilities − liquid assets)/total assets. They consider all loans with maturity of one year or less to be liquid, and they explicitly exclude loan commitments and other off-balance sheet activities because of their contingent nature. They find that the LT gap is about 20% of total assets on average for their sample of large banks. The authors conclude that these banks do not appear to create much liquidity, and run some tests to explain this finding, examining the roles of insured deposits, credit risk, and loan commitments.

The LT gap is an intuitive step forward, but we do not believe that it is sufficiently comprehensive. To illustrate, we highlight a few key differences between their approach and ours. First, we include virtually all commercial banks and compare findings for large, medium, and small banks, rather than including only the largest institutions. Second, our preferred "cat fat" liquidity creation measure classifies loans by category ("cat"), rather than by maturity. We treat business loans as illiquid regardless of their maturity because banks generally cannot easily dispose of them to meet liquidity needs, but we treat residential mortgages and consumer loans as semiliquid because these loans can often be securitized and sold to meet demands for liquid funds. Third, our preferred measure includes off-balance sheet activities ("fat"), consistent with the arguments in Holmstrom and Tirole (1998) and Kashyap, Rajan, and Stein (2002). In our less-preferred liquidity measures, we classify loans by maturity ("mat") and exclude off-balance sheet activities ("nonfat") to determine the effects of these assumptions. As discussed in Section 2, the LT gap is conceptually close to our "mat nonfat" measure.

1.2 Bank liquidity creation and capital: the theories

In the seminal theories on financial intermediary existence highlighted above, banks do not hold any capital. Bank capital was introduced in subsequent papers, which argue that the primary reason why banks hold capital is to absorb risk, including the risk of liquidity crunches, protection against bank runs, and various other risks, most importantly credit risk. Although the reason why banks hold capital is motivated by their risk transformation role, recent theories suggest that bank capital may also affect banks' ability to create liquidity. These theories produce opposing predictions on the link between capital and liquidity creation.

One set of theories, which we refer to collectively as the "financial fragility-crowding out" hypothesis, predicts that higher capital reduces liquidity creation. Diamond and Rajan (2000, 2001) focus on financial fragility. They model a relationship bank that raises funds from investors to provide financing to an entrepreneur. The entrepreneur may withhold effort, which reduces the amount of bank financing attainable. More importantly, the bank may also withhold effort, which limits the bank's ability to raise financing. A deposit contract mitigates the bank's holdup problem, because depositors can run on the bank if the bank threatens to withhold effort, and therefore maximizes liquidity creation. Providers of capital cannot run on the bank, which limits their willingness to provide funds, and hence reduces liquidity creation. Thus, the higher a bank's capital ratio, the less liquidity it will create.[6] Note that the negative effect of capital on liquidity creation as suggested by Diamond and Rajan (2000, 2001) depends crucially on deposit insurance coverage being incomplete. If insurance were complete, depositors would have no incentive to run on the bank, and a deposit contract would not mitigate the bank's holdup problem.

Gorton and Winton (2000) show how a higher capital ratio may reduce liquidity creation through the crowding out of deposits.[7] They argue that

[6] Diamond and Rajan's (2000, 2001) model builds on Calomiris and Kahn's (1991) argument that the ability of uninsured depositors to run on the bank in the event of expected wealth expropriation by bank managers is an important disciplining mechanism. A related idea is proposed by Flannery (1994), who focuses on the disciplining effect of depositors' ability to withdraw funds on demand, and thus prevent the bank from expropriating depositor wealth through excessively risky investments.

[7] A similar argument regarding capital requirements is made by Van den Heuvel (2008).

deposits are more effective liquidity hedges for investors than investments in equity capital and higher capital ratios shift investors' funds from deposits to bank capital. Since deposits are liquid and bank equity is illiquid, there is a reduction in overall liquidity for investors when the capital ratio is higher.[8]

While the theories underlying the "financial fragility-crowding out" hypothesis apply to banks of all sizes, we argue that they are most applicable to small banks. An essential feature of the Diamond and Rajan (2000, 2001) model is the bank's monitoring of the borrower using its borrower-specific skills, without which the loan's value diminishes. As the analyses in Berger et al. (2005) suggest, small banks engage in more relationship-specific lending involving bank monitoring than large banks. The Gorton and Winton (2000) model is general equilibrium and theoretically applies to all banks, but as an empirical matter the assumptions of their model seem to fit small banks better. In their model, there is a single, unsegmented capital market, so more bank equity capital implies less bank deposits. In reality, however, this is the case only in the smaller markets in which small banks operate. The larger (especially national and international) capital markets are often quite segmented, with investors segmenting themselves based on various characteristics, including investment style (e.g., choice of equity versus debt instruments). This implies that an increase in the bank's demand for equity capital may simply cause "equity investors" to shift out of other equities, rather than inducing a shift out of bank deposits. That is, changes in bank capital may induce general equilibrium effects, but these effects may be manifested in securities other than bank deposits. Further, bank equity capital in practice accounts for a relatively small fraction of total equity capital held by investors in the national/international capital markets. Thus, even if the "crowding out" effect by Gorton and Winton (2000) exists for large banks, it is likely to be empirically smaller than for small banks. Small banks operate in smaller, less segmented markets, where there is significant overlap between those who invest in bank equity and those who invest in bank deposits, and any increase in bank capital is more likely to crowd out deposits. A final and related reason why the crowding out effect may be stronger for small banks is that these banks fund themselves largely with deposits and capital. In contrast, large banks also use other liabilities that are less liquid than deposits (such as subordinated debt), suggesting that an increase in capital may lead to a drop in other liabilities rather than deposits. Thus, capital is more likely to crowd out deposits at small banks than at large banks.

Under the alternative "risk absorption" hypothesis, which is directly linked to the risk-transformation role of banks, higher capital enhances banks' ability to create liquidity. This insight is based on two strands of the literature. One strand consists of papers that argue that liquidity creation exposes banks to risk

[8] Gorton and Winton's (2000) analysis suggests that even if equityholders did not reduce funding to the bank in Diamond and Rajan (2000), there would be less liquidity creation with a higher capital ratio.

(e.g., Allen and Santomero 1998; Allen and Gale 2004). The more liquidity that is created, the greater is the likelihood and severity of losses associated with having to dispose of illiquid assets to meet the liquidity demands of customers. The second strand consists of papers that posit that bank capital absorbs risk and expands banks' risk-bearing capacity (e.g., Bhattacharya and Thakor 1993; Repullo 2004; Von Thadden 2004; Coval and Thakor 2005). Combining these two strands yields the prediction that higher capital ratios may allow banks to create more liquidity.

We argue that the risk absorption hypothesis applies more strongly to large banks than to small banks. The reasons are threefold. First, large banks are typically exposed to more intense regulatory scrutiny, increasing the value of capital to the banks as part of its overall risk management. Second, large banks are also subject to greater market discipline from uninsured providers of finance, so capital has a greater effect on both the cost and the availability of uninsured financing. Third, some large banks may see new opportunities to offer large loan commitments or engage in other off-balance sheet activities. Since these activities involve risk, these banks may boost equity capital in anticipation of engaging in these new activities.

Finally, we point out one additional contribution of some of the recent theories. The standard view of liquidity creation is that banks create liquidity by transforming illiquid assets into liquid liabilities. Diamond and Rajan (2000, 2001) and Gorton and Winton (2000) show, however, that banks can create more or less liquidity by simply changing their funding mix on the liability side. Thakor (1996) shows that capital may also affect banks' asset portfolio composition, thereby affecting liquidity creation through a change in the asset mix. Our measures of liquidity creation incorporate these insights—they explicitly recognize that liquidity creation by banks occurs through changes in the mixes on both sides of the balance sheet, as well as through off-balance sheet activities.

1.3 Bank capital and liquidity creation: the existing empirical evidence

Some empirical studies examine issues related to liquidity creation, but do not focus on the role of capital. Kashyap, Rajan, and Stein (2002) provide empirical evidence of synergies between commitment lending and deposits, consistent with their model. Gatev, Schuermann, and Strahan (2006) and Gatev and Strahan (2006) find that banks have a comparative advantage in hedging liquidity risk in the economy because banks experience deposit inflows following a market crisis or liquidity shock that allow them to have more funds to provide the additional loans drawn down under commitments at such times. Pennacchi (2006) confirms the existence of synergies between loan commitments and deposit taking, but finds that such synergies do not hold prior to the creation of FDIC deposit insurance. These studies do not focus on the role of bank capital, but they do in some cases include the capital ratios in regressions of some liquidity creation components, yielding ambiguous predictions related to the effect of capital on liquidity creation.[9]

The credit crunch literature tests hypotheses about bank capital and one type of liquidity creation, usually business lending or real estate lending, during the early 1990s when bank lending declined significantly. Several studies find that the decline in bank capital ratios arising from loan losses in the late 1980s and early 1990s contributed significantly to the reduction in lending (e.g., Peek and Rosengren 1995). This is consistent with a positive relationship between capital and liquidity creation during a period of distress. In the early 1990s, U.S. regulators also imposed new leverage requirements, as well as the Basel I risk-based capital standards. Most of the studies found that the leverage requirements contributed to the decline in lending, consistent with the hypothesis of a negative effect of bank capital on liquidity creation (e.g., Berger and Udell 1994; Hancock, Laing, and Wilcox 1995; Peek and Rosengren 1995), and generally concluded that the risk-based capital requirements had little effect on lending. Unfortunately, the unusual combination of several major changes in bank capital regulation and a recession makes it difficult to parse the different effects and draw general conclusions.

Finally, some studies of bank lending behavior include capital ratios, but focus on other issues. For example, Berger and Udell (2004) study procyclical lending and find positive, statistically significant effects of capital on the annual growth of business loans. Holod and Peek (2007) examine monetary policy effects and find that the capital ratio has significant positive effects on loan growth. Gambacorta and Mistrulli (2004) use Italian data and find that the impact of monetary policy and GDP shocks on bank lending depends on bank capitalization.

Thus, the existing empirical literature sheds relatively little light on the relationship between bank capital and liquidity creation. Some studies test the liquidity creation theories, but do not focus on the role of bank capital. Others include capital in their regressions, but specify only limited components of liquidity creation, and often under unusual circumstances. Our empirical analysis uses a significantly different approach.

2. Construction of Our Liquidity Creation Measures

In this section, we pursue our first main goal of developing measures of liquidity creation. We explain the construction of our four liquidity creation measures and clarify which is our preferred measure. We also show how Deep and Schaefer's (2004) liquidity transformation measure can be viewed as a special case of one of our measures.

[9] For example, Gatev and Strahan (2006) find that a higher bank capital ratio tends to be followed by greater loans and deposits (which may increase liquidity creation) and greater liquid assets and nondeposit liabilities (which may reduce liquidity creation).

We construct the liquidity creation measures using a three-step procedure. In step 1, we classify all bank balance sheet and off-balance sheet activities as liquid, semiliquid, or illiquid. In step 2, we assign weights to the activities classified in step 1. In step 3, we combine the activities as classified in step 1 and as weighted in step 2 in different ways to construct our four liquidity creation measures: "cat fat," "mat fat," "cat nonfat," and "mat nonfat." Table 1 illustrates the three-step procedure. We discuss these steps in turn.

2.1 Step 1: Classifying activities as liquid, semiliquid, or illiquid

In step 1, we classify all assets as liquid, semiliquid, or illiquid based on the ease, cost, and time for banks to dispose of their obligations to obtain liquid funds to meet customers' demands. We similarly classify bank liabilities plus equity as liquid, semiliquid, or illiquid, based on the ease, cost, and time for customers to obtain liquid funds from the bank. Off-balance sheet guarantees and derivatives are classified consistently with treatments of functionally similar on-balance sheet items.[10]

Ideally, we would use information on both product category and maturity to classify all bank activities. For example, as noted above, business loans are generally more illiquid than residential mortgages and consumer loans, as the latter can often be more easily securitized and sold to meet liquidity demands. Within each category, shorter maturity items are more liquid than longer maturity items because they self-liquidate without effort or cost sooner.

For bank activities other than loans, Call Reports provide sufficient detail on category and maturity, so our classifications incorporate both aspects. Unfortunately, this is not the case for loans. Call Reports split loans into various loan categories and into different maturity classes, but do not provide maturity information for individual loan categories. We therefore either classify loans entirely by category ("cat") or entirely by maturity ("mat"). Thus, our "cat" and "mat" liquidity creation measures constructed below classify loans either by category or maturity, but in all cases incorporate both key characteristics for other bank activities.

2.1.1 Assets

- *Classifying loans*

  (a) *Category ("cat"):* For the "cat" measures of liquidity creation, we classify business loans and leases as illiquid assets, because these items typically cannot be sold quickly without incurring a major loss. Residential mortgages and consumer loans are generally relatively easy to securitize, and loans to depositories and governments are likely to be comparatively easy to sell or otherwise dispose of because the

[10] In a robustness check, we use an alternative approach to measuring the liquidity contribution of some of these items (see Section 6.1).

Table 1
Liquidity classification of bank activities and construction of four liquidity creation measures

Step 1: We classify all bank activities as liquid, semiliquid, or illiquid. For activities other than loans, we combine information on product category and maturity. Due to data limitations, we classify loans entirely by product category ("cat") or maturity ("mat")
Step 2: We assign weights to the activities classified in step 1

Assets

Illiquid assets (weight = $^1/_2$)		Semiliquid assets (weight = 0)		Liquid assets (weight = $-^1/_2$)
(cat)	(mat)	(cat)	(mat)	
Commercial real estate loans (CRE)	All loans and leases with a remaining maturity >1 year	Residential real estate loans (RRE)	All loans and leases with a remaining maturity ≤ 1 year	Cash and due from other institutions
Loans to finance agricultural production		Consumer loans		All securities (regardless of maturity)
Commercial and industrial loans (C&I)		Loans to depository institutions		Trading assets
Other loans and lease financing receivables		Loans to state and local governments		Fed funds sold
		Loans to foreign governments		
Other real estate owned (OREO)				
Customers' liability on bankers acceptances				
Investment in unconsolidated subsidiaries				
Intangible assets				
Premises				
Other assets				

Liabilities plus equity

Liquid liabilities (weight = $^1/_2$)	Semiliquid liabilities (weight = 0)	Illiquid liabilities plus equity (weight = $-^1/_2$)
Transactions deposits	Time deposits	Bank's liability on bankers acceptances
Savings deposits	Other borrowed money	Subordinated debt
Overnight federal funds purchased		Other liabilities
Trading liabilities		Equity

(*continued overleaf*)

Table 1
(Continued)

Off-balance sheet guarantees (notional values)		
Illiquid guarantees (weight = $^1/_2$)	Semiliquid guarantees (weight = 0)	Liquid guarantees (weight = $-^1/_2$)
Unused commitments Net standby letters of credit Commercial and similar letters of credit All other off-balance sheet liabilities	Net credit derivatives Net securities lent	Net participations acquired

Off-balance sheet derivatives (gross fair values)		
		Liquid derivatives (weight = $-^1/_2$)
		Interest rate derivatives Foreign exchange derivatives Equity and commodity derivatives

Step 3: We combine bank activities as classified in step 1 and as weighted in step 2 in different ways to construct four liquidity creation measures by using the "cat" or "mat" classification for loans, and by alternatively including off-balance sheet activities ("fat") or excluding these activities ("nonfat")

cat fat =	$+^1/_2$ * illiquid assets (cat) $+^1/_2$ * liquid liabilities $+^1/_2$ * illiquid guarantees	+0 * semiliquid assets (cat) +0 * semiliquid liabilities +0 * semiliquid guarantees	$-^1/_2$ * liquid assets $-^1/_2$ * illiquid liabilities $-^1/_2$ * equity $-^1/_2$ * liquid guarantees $-^1/_2$ * liquid derivatives
cat nonfat =	$+^1/_2$ * illiquid assets (cat) $+^1/_2$ * liquid liabilities	+0 * semiliquid assets (cat) +0 * semiliquid liabilities	$-^1/_2$ * liquid assets $-^1/_2$ * illiquid liabilities $-^1/_2$ * equity
mat fat =	$+^1/_2$ * illiquid assets (mat) $+^1/_2$ * liquid liabilities $+^1/_2$ * illiquid guarantees	+0 * semiliquid assets (mat) +0 * semiliquid liabilities +0 * semiliquid guarantees	$-^1/_2$ * liquid assets $-^1/_2$ * illiquid liabilities $-^1/_2$ * equity $-^1/_2$ * liquid guarantees $-^1/_2$ * liquid derivatives
mat nonfat =	$+^1/_2$ * illiquid assets (mat) $+^1/_2$ * liquid liabilities	+0 * semiliquid assets (mat) +0 * semiliquid liabilities	$-^1/_2$ * liquid assets $-^1/_2$ * illiquid liabilities $-^1/_2$ * equity

This table explains our methodology to construct liquidity creation measures in three steps.

counterparties are relatively large and informationally transparent. We classify these loan categories as semiliquid assets.[11]

(b) *Maturity ("mat"):* Shorter maturity items are more liquid than longer maturity items because they self-liquidate sooner. We therefore classify all short-term loans of up to one year as semiliquid and all long-term loans of over one year as illiquid for the "mat" measures.

- *Classifying assets other than loans:* We classify premises and investments in unconsolidated subsidiaries as illiquid assets, because typically these items cannot be sold quickly without incurring a major loss. We classify cash, securities, and other marketable assets that the bank can use to meet liquidity needs quickly without incurring major losses as liquid assets.

2.1.2 Liabilities plus equity

- *Classifying liabilities:* We count funds that can be quickly withdrawn without penalty by customers, such as transactions deposits, savings deposits, and overnight federal funds purchased, as liquid liabilities. We classify deposits that can be withdrawn with slightly more difficulty or penalty as semiliquid. This includes all time deposits regardless of maturity. We do not differentiate between short-term and long-term time deposits since all time deposits can be borrowed against with a penalty regardless of maturity. We also classify as semiliquid the balance sheet item "other borrowed money," which contains other short and medium maturities with terms longer than overnight, such as term federal funds, repurchase agreements, and borrowings from Federal Reserve Banks and Federal Home Loan Banks. We classify long-term liabilities that generally cannot be withdrawn easily or quickly, such as subordinated debt, as illiquid.
- *Classifying equity:* We classify equity as illiquid because investors cannot demand liquid funds from the bank and the maturity is very long. Although the equity of some banks is publicly traded and may be sold relatively easily, the investors are able to retrieve liquid funds through the capital market, not from the bank. Thus, while traded equity may be liquid from an individual investor's point of view, such liquidity is created by the capital market, rather than by the bank, the focus of this article.

2.1.3 Off-balance sheet activities

- *Classifying guarantees:* We classify loan commitments and letters of credit as illiquid guarantees. These items are functionally similar to on-balance sheet business loans in that they are obligations that are illiquid from the

[11] In a robustness check, we use a different method to establishing which loans are securitizable (see Section 6.2).

point of view of the bank; except in very unusual circumstances, the bank must provide the funds to the customer upon demand.[12] As well, in most cases, the bank cannot sell or participate these items. We classify net credit derivatives (i.e., the amount guaranteed minus the beneficiary amount) and net securities lent (i.e., the amount lent minus the amount borrowed) as semiliquid guarantees since they can potentially be sold or participated, analogous to semiliquid on-balance sheet residential mortgages and consumer loans. We classify net participations acquired from other institutions (i.e., the amount acquired minus the amount conveyed to others) as liquid guarantees, since they are functionally similar to on-balance sheet liquid securities.

- *Classifying derivatives:* We classify all derivatives (other than credit derivatives, which we classify above as guarantees)—interest rate, foreign exchange, and equity and commodity derivatives—as liquid because they can be bought and sold easily and are functionally similar to liquid securities. We focus on the gross fair values of these derivatives (which are sometimes positive and sometimes negative), which measure how much liquidity the bank is providing to or absorbing from the public.

2.2 Step 2: Assigning weights to the activities classified in step 1

In step 2, we assign weights to all of the bank activities classified in step 1. That is, we assign weights to the classes of liquid, semiliquid, and illiquid assets, liabilities plus equity, and off-balance sheet guarantees and derivatives shown in Table 1.

We base the weights on liquidity creation theory. According to this theory, banks create liquidity on the balance sheet when they transform illiquid assets into liquid liabilities. An intuition for this is that banks create liquidity because they hold illiquid items in place of the nonbank public and give the public liquid items. We therefore apply positive weights to both illiquid assets and liquid liabilities, so when liquid liabilities (such as transactions deposits) are used to finance illiquid assets (such as business loans), liquidity is created. Following similar logic, we apply negative weights to liquid assets, illiquid liabilities, and equity, so that when illiquid liabilities or equity is used to finance a dollar of liquid assets (such as treasury securities), liquidity is destroyed. Note that the negative weight on equity only captures the direct effect of capital on liquidity creation. Any indirect (positive or negative) effects on liquidity creation are attributed to the individual items that are affected. For example, if capital allows banks to extend more illiquid loans, this positive effect is captured by the positive weight applied to illiquid loans multiplied by the associated dollar increase in loans.

[12] We acknowledge that banks could dispose of loan commitments by invoking the material adverse change (MAC) clause and the customer would not have access to the funds. However, failing to honor loan commitments is generally very costly since it may create legal liabilities and reputational losses, and is therefore rarely done.

The magnitudes of the weights are based on simple dollar-for-dollar adding-up constraints, so that \$1 of liquidity is created when banks transform \$1 of illiquid assets into \$1 of liquid liabilities. Similarly, we require that \$1 of liquidity is destroyed when banks transform \$1 of liquid assets into \$1 of illiquid liabilities. Based on these constraints, we assign a weight of ½ to both illiquid assets and liquid liabilities and a weight of −½ to both liquid assets and illiquid liabilities. Thus, when a dollar of liquid liabilities (such as transactions deposits) is used to finance a dollar of illiquid assets (such as business loans), liquidity creation equals ½ * \$1 + ½ * \$1 = \$1. In this case, maximum liquidity (\$1) is created. Intuitively, the weight of ½ applies to both illiquid assets and liquid liabilities, since the amount of liquidity created is only "half" determined by the source or use of the funds alone—both are needed to create liquidity. Similarly, when a dollar of illiquid liabilities or equity is used to finance a dollar of liquid assets (such as treasury securities), liquidity creation equals −½ * \$1 + −½ * \$1 = −\$1, as maximum liquidity is destroyed.

Using these weights, banks do not create liquidity when they use liquid liabilities (e.g., transaction deposits) to finance liquid assets (e.g., treasuries), or when they use illiquid liabilities or equity to finance illiquid assets (e.g., business loans). In these cases, banks hold items of approximately the same liquidity as they give to the nonbank public.

We apply the intermediate weight of 0 to semiliquid assets and liabilities, based on the assumption that semiliquid activities fall halfway between liquid and illiquid activities. Thus, the use of time deposits to fund residential mortgages would yield approximately zero net liquidity creation, since the ease, cost, and time with which the time depositors may access their funds early and demand liquidity roughly equals the ease, cost, and time with which the bank can securitize and sell the mortgage to provide the funds.

We apply weights to off-balance sheet guarantees and derivatives using the same principles, consistent with the functional similarities to on-balance sheet items discussed in step 1. For example, illiquid off-balance sheet guarantees (such as loan commitments) are functionally similar to on-balance sheet illiquid loans (such as business loans) in that they are obligations of the bank to provide funds that cannot be easily sold or participated. We therefore apply the same weight of ½ to illiquid guarantees as we do to illiquid assets. Similarly, we apply the same weight of 0 to semiliquid guarantees as we do to functionally similar semiliquid on-balance sheet assets, and we apply the same weight of −½ to liquid guarantees that we do to functionally similar on-balance sheet liquid assets.

Analogously, the gross fair values of derivatives are assigned the same weight of −½ as on-balance sheet liquid assets.[13] As discussed in step 1, these

[13] Fair values reported in Call Reports are as in FASB 133: the amount at which an asset (liability) could be bought (incurred) or sold (settled) in a current transaction between willing parties, that is, other than in a forced or liquidation sale. The fair value equals the quoted market price, if available. If a quoted market price is not available, the estimate of fair value is based on the best information available in the circumstances.

contracts can be bought and sold easily and are functionally similar to liquid securities. Like securities, derivatives with gross positive fair values reduce bank liquidity creation as the bank effectively holds a valuable liquid asset in place of the public. Derivatives with gross negative fair values increase bank liquidity creation as the bank effectively holds a negatively valued liquid asset in place of the public. Since the Call Reports assign positive values to contracts with gross positive fair values and negative values to those with gross negative fair values, we capture these opposing effects on liquidity creation by simply applying weights of $-½$ to the dollar values of both.[14, 15]

We arrange the columns in Table 1 such that all the bank activities that contribute to liquidity creation are on the left, all those that subtract from liquidity creation are on the right, and all those with an approximately neutral effect on liquidity creation are in the center. Thus, those that are assigned a weight of ½ —illiquid assets, liquid liabilities, and illiquid guarantees—are grouped together on the left. Liquid assets, illiquid liabilities plus equity, and liquid guarantees and derivatives, which are assigned a weight of $-^1/_2$, are grouped on the right. Finally, semiliquid assets, liabilities, and guarantees with 0 weights are grouped in the center.

2.3 Step 3: Constructing liquidity creation measures by combining activities as classified in step 1 and as weighted in step 2

In step 3, we combine the activities as classified and weighted in step 1 and step 2, respectively, in different ways to construct our liquidity creation measures. The measures are similar in that they all classify activities other than loans using information on product category and maturity, as discussed in step 1. The measures differ in that we alternatively classify loans by category or maturity ("cat" versus "mat"), and—to gauge how much liquidity banks create off the balance sheet—alternatively include or exclude off-balance sheet activities ("fat" versus "nonfat"). Hence, we have four measures: "cat fat," "cat nonfat," "mat fat," and "mat nonfat." The formulas are shown in Table 1. In Table 1, we again arrange the bank activities that add to liquidity creation on the left, those that subtract from liquidity creation on the right, and those with an approximately neutral effect in the center. For all measures, we multiply the weights of $^1/_2$, $-^1/_2$, or 0, respectively, times the dollar amounts of the corresponding bank activities and add the weighted dollar amounts to arrive at the total dollar value

[14] While the gross positive and negative fair values of derivatives are often quite substantial, most banks operate with nearly matched books, so these values tend to offset each other, yielding a small net contribution to liquidity creation.

[15] The seminal papers say nothing about the role that derivatives play in the liquidity creation function of banks. Rather, derivatives play a more major role in the risk-transformation function of banks. Nonetheless, it is important to consider the contribution of all balance sheet and off-balance sheet activities to liquidity creation in our measurement, whether or not the theory has spoken on these activities. Thus, for measurement purposes, we take the gross fair values of liquid derivatives and assign a weight consistent with that of a functionally similar on-balance sheet item, which in this case is liquid securities.

of liquidity creation at a particular bank. We sum across all banks to obtain the total dollar value of liquidity created by the entire industry.

We recognize that our liquidity creation measures are rough approximations. We classify all bank activities as liquid, semiliquid, or illiquid, and use three weights, $\frac{1}{2}$, 0, and $-\frac{1}{2}$. Differences in liquidity obviously exist within each of the three classifications, but the data generally do not allow for much finer distinctions, and there are no other unambiguous weights to apply. The use of $\frac{1}{2}$, $-\frac{1}{2}$, and 0 are the clear demarcations of full liquidity, full illiquidity, and neutrality, respectively, and no other clear choices present themselves.

Note that Deep and Schaefer's (2004) LT gap measure is conceptually close to our "mat nonfat" measure and may be viewed as a special case of it. If we classified all assets and liabilities as either liquid or illiquid (none as semiliquid) using maturities, excluded off-balance sheet activities, and specified assets (A) rather than gross total assets (GTA), our "mat nonfat" formula reduces to their formula.[16]

We next discuss why we consider "cat fat" to be our preferred liquidity creation measure. First, we argue that the "cat" measures are preferred to the "mat" measures primarily because what matters to liquidity creation on the asset side is the ease, cost, and time for banks to dispose of their obligations to obtain liquid funds. The ability to securitize loans is closer to this concept than the time until self-liquidation. For example, a 30-year residential mortgage may be securitized relatively quickly even though it is a long-term loan. Second, we argue that the "fat" measures are preferred to the "nonfat" measures because off-balance sheet activities provide liquidity in functionally similar ways to on-balance sheet items. Hence, "cat fat" is our preferred measure.

3. Bank Liquidity Creation over Time, in the Cross Section, and Value Implications

In this section, we pursue our second main goal of gaining a deeper insight into banks' role as liquidity creators by applying our four measures to data on the U.S. banking sector. We first describe how we construct our sample. We then measure how much liquidity banks create. We next explore the time-series and cross-sectional variation in bank liquidity creation, and examine the characteristics of banks that create the most and least liquidity over the sample period. In all of these analyses, we split the sample by size. In addition, we divide the data by bank holding company status, wholesale versus retail orientation, and merger status. Finally, we explore the value implications of bank liquidity creation.

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[16] Applying these changes, our formula becomes [$\frac{1}{2}$ * illiquid assets $-$ $\frac{1}{2}$ * liquid assets $+$ $\frac{1}{2}$ * liquid liabilities $-$ $\frac{1}{2}$ * illiquid liabilities $-$ $\frac{1}{2}$ * equity]/A = [$\frac{1}{2}$ * (A $-$ liquid assets) $-$ $\frac{1}{2}$ * liquid assets $+$ $\frac{1}{2}$ * (liquid liabilities) $-$ $\frac{1}{2}$ * (A $-$ liquid liabilities)]/A = [liquid liabilities $-$ liquid assets]/A, which is their LT gap measure.

3.1 Sample description

Our sample includes almost all commercial banks in the United States that are in business during the 1993 to 2003 period. To ensure that our sample only contains "true," viable commercial banks, we impose the following restrictions. We exclude a bank if it (1) has no commercial real estate or commercial and industrial loans outstanding; (2) has zero deposits; (3) has zero or negative equity capital in the current or lagged year; (4) is very small (average lagged *GTA* below $25 million);[17] (5) has unused commitments exceeding four times *GTA*; (6) resembles a thrift (residential real estate loans exceeding 50% of *GTA*); or (7) is classified by the Federal Reserve as a credit card bank or has consumer loans exceeding 50% of *GTA*.[18] We also eliminate 0.7% of all bank-year observations because some of the exogenous variables used in our regression analysis are missing.

For all the banks in our sample, we obtain annual Call Report data as of 31 December of each year. In all of our analyses, we split the sample by size for several reasons. First, there are many empirical studies that show that size matters when studying components of bank liquidity creation. For example, Berger et al. (2005) argue that large and small banks have comparative advantages in handling different types of credit information, and hence will extend different types of loans. They split their sample by bank size, and indeed find that large and small banks make very different loans. Furthermore, Kashyap, Rajan, and Stein (2002) provide empirical evidence that the relationship between commitments and transactions deposits is different for banks in different size classes. Second, although there are no theories that argue that the effect of capital on liquidity creation depends on bank size, we expect that the net effect of capital on liquidity creation would be different for banks of different size classes. As shown in Sections 5 and 6, we find confirming empirical evidence. Thus, we split the sample into large banks (*GTA* exceeding $3 billion), medium banks (*GTA* $1 billion–$3 billion), and small banks (*GTA* up to $1 billion).[19]

Our definition of small banks with *GTA* of up to $1 billion conforms to the usual notion of "community banks" that primarily create liquidity by transforming locally generated deposits into local loans on the balance sheet.[20] We divide the remaining observations roughly in half with the $3 billion cutoff for

[17] Banks with lagged average *GTA* below $25 million are not likely to be viable commercial banks in equilibrium. This exclusion reduced the sample size by 12,955 bank-year observations (from 96,953 to 83,998), but does not materially affect our findings. Inclusion of these banks increases liquidity creation of small banks by only 0.1% ($0.0027 trillion) in 2003 based on our "cat fat" measure, and leaves our regression results qualitatively unchanged.

[18] The Federal Reserve Board defines a credit card bank as having (1) 50% or more of its total assets in the form of loans to individuals; (2) 90% or more of its loans to individuals in the form of credit card outstandings; and (3) $200 million or more in loans to individuals.

[19] We apply the $3 billion and $1 billion cutoffs, measured in real 2003 dollars, in each year to separate the banks in our sample into large, medium, and small banks.

[20] We also tried splitting small banks into banks with *GTA* up to $100 million and banks with *GTA* $100 million–$1 billion. Since the regression results presented in Sections 5 and 6 yielded very similar results for both size classes, we decided not to pursue this finer partitioning of the data.

GTA. Large banks with *GTA* over $3 billion create much more liquidity off the balance sheet than small banks. Large institutions also tend to generate and disperse on-balance sheet funds on more national and international bases than small institutions. Medium banks with *GTA* between $1 billion and $3 billion tend to have portfolios that mix some of the characteristics of small and large banks.

Our sample contains 83,998 bank-year observations: 1804 for large banks, 2132 for medium banks, and 80,062 for small banks.

3.2 Liquidity creation over time and in the cross section for banks split by size and by bank holding company status, wholesale versus retail orientation, and merger status

We next measure how much liquidity banks create and explore how liquidity creation has changed over time and how it varies in the cross section. We initially split banks only by size, and then we also divide banks by bank holding company status, wholesale versus retail orientation, and merger status.

Panel A of Table 2 shows the summary statistics on bank liquidity creation based on our four measures for the entire banking sector and separately for large, medium, and small banks in 1993 and in 2003, the first and last years of our sample period, respectively. It also shows graphs of liquidity creation over the entire sample period using the corresponding measures. As shown, due to consolidation of the banking industry, the numbers of observations of large and small banks fell by about one-quarter each, while the number of medium banks remained approximately constant. Overall, the number of banks in the sample fell by about 23% from 9095 in 1993 to 6968 in 2003.

We find that banks created liquidity of $2.843 trillion in 2003 based on our preferred "cat fat" measure, which classifies loans by category and includes off-balance sheet activities (see panel A of Table 2).[21] Liquidity creation equals 39% of industry *GTA* and represents $4.56 of liquidity per $1 of equity capital. It is about 70% as large as gross loans and 58% as large as total deposits, which are standard asset and liability measures of bank size. Overall liquidity creation almost doubled in real terms between 1993 and 2003. As shown, liquidity creation also increased as a fraction of *GTA*, equity, gross loans, and total deposits, suggesting that liquidity creation grew at a faster rate than these items.

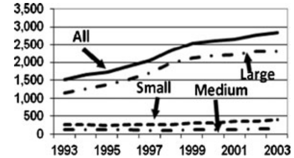
Large banks created 81% of industry liquidity at the end of the sample period, despite representing only about 2% of the sample observations. Medium and small banks generated only about 5% and 14% of industry liquidity creation as of 2003, respectively, despite their greater numbers of observations. Medium

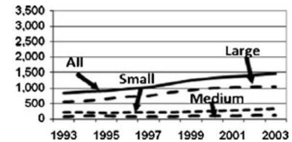
[21] Applying the formula given in step 3 of Table 1: liquidity creation = ½ * illiquid assets of $2.752 trillion + 0 * semiliquid assets of $1.905 trillion − ½ * liquid assets of $2.550 trillion + ½ * liquid liabilities of $3.718 trillion + 0 * semiliquid liabilities of $1.777 trillion − ½ * illiquid liabilities of $0.370 trillion − ½ * equity of $0.624 + ½ * illiquid guarantees of $2.781 trillion + 0 * semiliquid guarantees of $0.782 trillion − ½ * liquid guarantees of −$0.001 trillion − ½ * liquid derivatives of $0.023 trillion = $2.843 trillion.

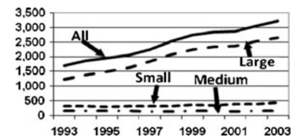
Table 2
Summary statistics on bank liquidity creation

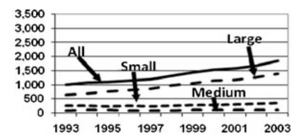
Panel A: Bank liquidity creation over time (1993–2003) and in the cross section using our four liquidity creation measures for banks split by size

Liquidity creation measure		1993 liquidity creation						2003 liquidity creation						Liquidity creation 1993–2003
		N	*LC* $ *bill*	*LC/GTA*	*LC/EQ*	*LC/LNS*	*LC/DEP*	*N*	*LC* $ *bill*	*LC/GTA*	*LC/EQ*	*LC/LNS*	*LC/DEP*	$ *billion*
cat fat (preferred)	All banks	9095	1523	0.34	4.36	0.60	0.46	6968	2843	0.39	4.56	0.70	0.58	
	Large	205	1154	0.40	5.44	0.70	0.58	143	2298	0.41	4.93	0.75	0.64	
	Medium	208	115	0.30	3.73	0.53	0.38	205	149	0.38	3.69	0.61	0.51	
	Small	8682	254	0.21	2.40	0.39	0.25	6620	396	0.33	3.37	0.51	0.40	
cat nonfat	All banks	9095	830	0.19	2.38	0.33	0.25	6968	1463	0.20	2.35	0.36	0.30	
	Large	205	562	0.19	2.65	0.34	0.28	143	1041	0.19	2.23	0.34	0.34	
	Medium	208	73	0.19	2.37	0.33	0.24	205	108	0.27	2.68	0.44	0.44	
	Small	8682	195	0.16	1.84	0.30	0.19	6620	315	0.26	2.67	0.41	0.41	
mat fat	All banks	9095	1693	0.38	4.85	0.67	0.51	6968	3234	0.45	5.18	0.79	0.66	
	Large	205	1224	0.42	5.77	0.74	0.61	143	2647	0.47	5.68	0.86	0.86	
	Medium	208	144	0.38	4.68	0.66	0.48	205	160	0.41	3.98	0.66	0.66	
	Small	8682	324	0.27	3.06	0.50	0.32	6620	427	0.35	3.63	0.55	0.55	
mat nonfat	All banks	9095	1000	0.22	2.87	0.40	0.30	6968	1855	0.26	2.97	0.45	0.38	
	Large	205	633	0.22	2.98	0.38	0.32	143	1391	0.25	2.98	0.45	0.45	
	Medium	208	102	0.27	3.32	0.47	0.34	205	119	0.30	2.96	0.49	0.49	
	Small	8682	265	0.22	2.50	0.41	0.26	6,620	345	0.28	2.93	0.45	0.45	



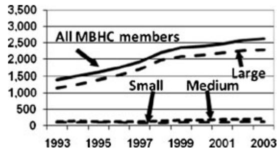




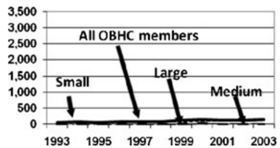


Panel B: Bank liquidity creation over time (1993–2003) and in the cross section using our preferred “cat fat” measure for banks in each size class split by bank holding company status, wholesale versus retail orientation, and merger status

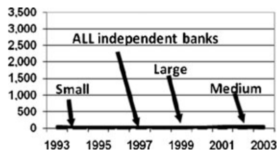
	N 1993	*N* 2003	Liquidity creation 1993–2003 $ *billion*
Multibank holding company (MBHC) members			
All banks	3323	2681	
Large	195	136	
Medium	168	164	
Small	2960	2381	



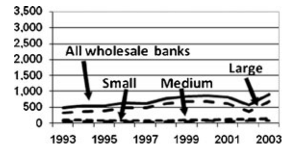
	N 1993	*N* 2003	Liquidity creation 1993–2003 $ *billion*
One-bank holding company (OBHC) members			
All banks	3397	3022	
Large	4	3	
Medium	14	22	
Small	3379	2997	



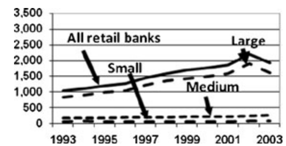
	N 1993	*N* 2003	Liquidity creation 1993–2003 $ *billion*
Independent banks			
All banks	2375	1265	
Large	6	4	
Medium	26	19	
Small	2343	1242	



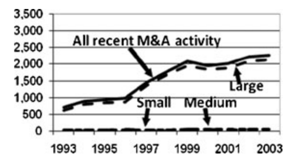
	N 1993	*N* 2003	Liquidity creation 1993–2003 $ *billion*
Wholesale banks (below average number of branches)			
All banks	6659	4809	
Large	131	106	
Medium	131	113	
Small	6397	4590	



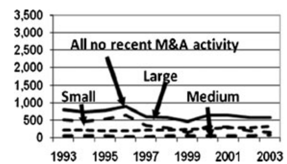
	N 1993	*N* 2003	Liquidity creation 1993–2003 $ *billion*
Retail banks (above average number of branches)			
All banks	2436	2159	
Large	74	37	
Medium	77	92	
Small	2285	2030	



	N 1993	*N* 2003	Liquidity creation 1993–2003 $ *billion*
Recent M&A activity (engaged in M&As during prior three years)			
All banks	694	576	
Large	95	98	
Medium	73	73	
Small	526	405	



	N 1993	*N* 2003	Liquidity creation 1993–2003 $ *billion*
No recent M&A activity			
All banks	8401	6392	
Large	110	45	
Medium	135	132	
Small	8156	6215	



(*continued overleaf*)

Table 2
(Continued)

Panel C: Characteristics of banks that create the most and least liquidity over 1993–2003 in each size class using our preferred "cat fat" measure

Banks split by		Large banks		Medium banks		Small banks	
		High liquidity creators (top 25%)	Low liquidity creators (bottom 25%)	High liquidity creators (top 25%)	Low liquidity creators (bottom 25%)	High liquidity creators (top 25%)	Low liquidity creators (bottom 25%)
Overall *LC*	A. Average liquidity creation ($ billion)	36.00	0.67	1.20	0.12	0.12	−0.00
	Composition of high and low liquidity creators						
	a. MBHC members	0.99	0.85	0.93	0.56	0.54	0.20
	b. OBHC members	0.01	0.05	0.05	0.16	0.31	0.46
	c. Independent banks	0.00	0.10	0.01	0.28	0.15	0.34
	a. Wholesale banks	0.25	0.97	0.47	0.76	0.29	0.91
	b. Retail banks	0.75	0.03	0.53	0.24	0.71	0.09
	a. Recent M&A activity	0.74	0.47	0.52	0.28	0.16	0.02
	b. No recent M&A activity	0.26	0.53	0.48	0.72	0.84	0.98
LC/*GTA*	B. Average liquidity creation/*GTA*	0.66	0.15	0.57	0.08	0.43	0.00
	Composition of high and low liquidity creators						
	a. MBHC members	0.99	0.84	0.89	0.59	0.45	0.22
	b. OBHC members	0.00	0.06	0.07	0.14	0.36	0.45
	c. Independent banks	0.00	0.10	0.03	0.27	0.19	0.33
	a. Wholesale banks	0.60	0.86	0.62	0.68	0.58	0.83
	b. Retail banks	0.40	0.14	0.38	0.32	0.42	0.17
	a. Recent M&A activity	0.63	0.53	0.41	0.31	0.10	0.03
	b. No recent M&A activity	0.37	0.47	0.59	0.69	0.90	0.97

LC/EQ	C. Average liquidity creation/equity	8.56	1.78	6.9	0.92	5.35	0.07
	Composition of high and low liquidity creators						
	a. MBHC members	1.00	0.84	0.89	0.58	0.46	0.21
	b. OBHC members	0.00	0.06	0.07	0.13	0.36	0.45
	c. Independent banks	0.00	0.10	0.04	0.29	0.18	0.34
	a. Wholesale banks	0.57	0.88	0.60	0.68	0.57	0.84
	b. Retail banks	0.43	0.12	0.40	0.32	0.43	0.16
	a. Recent M&A activity	0.62	0.52	0.39	0.31	0.10	0.03
	b. No recent M&A activity	0.38	0.48	0.61	0.69	0.90	0.97

Panel A shows liquidity creation of the banking sector in $ billion and divided by gross total assets (*GTA*, i.e., total assets plus the allowance for loan and lease losses and the allocated transfer risk reserve (a reserve for certain foreign loans)), equity (EQ), gross loans (LNS), and deposits (DEP) from 1993 to 2003. Panel B contains graphs of liquidity creation by banks split by BHC status, wholesale versus retail orientation, and merger status. Panel C uses these bank characteristics to contrast banks that create the most and least liquidity (top 25% and bottom 25% in each size class, respectively) over 1993–2003. All panels show results for large banks (*GTA* exceeding $3 billion), medium banks (*GTA* $1 billion–$3 billion), and small banks (*GTA* up to $1 billion). Panel A measures liquidity creation using all four liquidity creation measures as defined in Table 1, while panels B and C only show liquidity creation based on our preferred "cat fat" measure. All financial values are expressed in real 2003 dollars using the implicit GDP price deflator. The cat (mat) liquidity creation measures classify all bank activities other than loans based on product category and maturity, and loans by category (maturity) only. The fat (nonfat) liquidity creation measures include (exclude) off-balance sheet activities.

and small institutions also had slightly lower ratios of liquidity creation divided by *GTA*, equity, gross loans, and total deposits than large banks. As will be shown, this is because these institutions generated much less liquidity off the balance sheet. At large banks, liquidity creation doubled in real dollars, although it only rose as a fraction of *GTA* from 40% in 1993 to 41% in 2003. Perhaps surprisingly, small banks showed the greatest increase in liquidity creation divided by *GTA*, equity, gross loans, and total deposits.

As shown in the "cat fat" graph in panel A of Table 2, liquidity creation based on this measure increased in every year from 1993 to 2003. This was primarily driven by large banks—medium and small banks experienced smaller, nonmonotonic increases in liquidity creation. The increase in overall liquidity creation was driven by substantial growth in illiquid assets, liquid liabilities, and illiquid guarantees, which outweighed smaller increases in liquid assets, illiquid liabilities, and equity.

Liquidity creation is almost 50% less based on our "cat nonfat" measure, which is the same as "cat fat" except for the exclusion of off-balance sheet activities. Large banks still created most of the industry's liquidity, although the percentage is lower (71% as of 2003 versus 81% based on our "cat fat" measure). As shown in the "cat nonfat" graph, liquidity creation based on this measure also increased in every year of the sample period, primarily due to increases by large banks. Liquidity creation by medium and small banks experienced smaller, nonmonotonic increases in liquidity creation.

A comparison of liquidity creation based on the "cat fat" and "cat nonfat" measures reveals that banks create almost half of their liquidity off the balance sheet. This highlights the importance of including off-balance sheet activities. Although banks engage in a variety of off-balance sheet activities, the main drivers of off-balance sheet liquidity creation are illiquid guarantees of $2.781 trillion, in particular unused commitments ($2.426 trillion) and, to a lesser extent, net standby letters of credit ($0.287 trillion).[22] Derivatives ($0.023 trillion) are not among the major components of off-balance sheet liquidity creation. As noted in Section 2.2, while banks may have substantial derivatives portfolios, most operate with nearly matched books, so gross positive and negative fair values tend to offset each other. As an interesting side note, we also find that unused commitments, C&I commitments (a subset of unused commitments), net standby letters of credit, and commercial and similar letters of credit are all highly positively and significantly correlated with transactions deposits ($\rho = 0.73$, 0.81, 0.80, and 0.68, respectively), consistent with the predictions and findings of Kashyap, Rajan, and Stein (2002).

A second insight gained from comparing liquidity creation based on our "cat fat" and "cat nonfat" measures is that large, medium, and small banks create liquidity in very different ways. For example, as of 2003, unused loan

[22] Commercial and similar letters of credit and other off-balance sheet liabilities only amounted to $0.024 trillion and $0.043 trillion, respectively.

commitments equal 48% of total liquidity created by large banks, while only amounting to 26% and 19% of liquidity created by medium and small banks, respectively. Commercial real estate, on the other hand, equals only 12% of total liquidity creation for large banks, while equaling 36% and 42% of liquidity creation for medium and small banks, respectively. Similarly, for large banks, transactions deposits equal only 9% of total liquidity creation, whereas the corresponding figures for medium and small banks are 15% and 31%, respectively (not shown for reasons of brevity).

We now turn to liquidity creation based on our "mat" measures. Liquidity creation is the highest in all years using our "mat fat" measure, which differs from our preferred "cat fat" measure by using loan maturities in place of categories to classify loans. Treating all loans with maturity of at least one year as illiquid assets increases measured liquidity creation primarily because most residential mortgages are classified as illiquid (weight = $^1/_2$). Recall that these mortgages are classified as semiliquid (weight = 0) in the "cat fat" measure because they are relatively easy to securitize. The "mat fat" pattern of liquidity creation over time is similar to the "cat fat" pattern. The "mat nonfat" measure, which uses loan maturities and excludes off-balance sheet activities, yields much smaller measured liquidity creation. The "mat nonfat" liquidity creation pattern resembles the pattern of the other measures, increasing in all periods, driven by the large banks.

To understand more deeply how liquidity creation has changed over time and how it varies in the cross section, we split banks in each size class based on three additional characteristics. First, we divide banks by bank holding company status into multibank holding company (MBHC) members, one-bank holding company (OBHC) members, and independent banks. Second, we divide banks by wholesale versus retail orientation, defined here as having below-average and above-average numbers of branches for their size class, respectively. Third, we split banks by merger status: those that did and did not engage in mergers and acquisitions during the prior three years. For each subsample, we show the numbers of banks in 1993 and 2003, and present graphs that highlight how liquidity creation has changed over time (see panel B of Table 2). For brevity, we focus on liquidity creation based on our preferred "cat fat" measure.

Panel B of Table 2 contains the results. As shown on the left, the vast majority of large and medium banks are in MBHCs, while small banks are more evenly divided among the three governance structures. As the graphs make clear, MBHC members created most of the overall industry liquidity creation, and these banks also experienced the greatest increase in liquidity creation. Within each size class, MBHC members also created the most liquidity.

As shown on the top right in panel B of Table 2, most of the banks have wholesale orientation by our definition, but retail banks create most of overall industry liquidity. This result is driven by large and small banks; among medium banks, liquidity created by retail and wholesale banks is similar. As shown, liquidity creation grows in each year for both retail and wholesale banks, except for the spikes in 2002 and 2003. These spikes occur because Citibank shifted from a wholesale bank to a retail bank in 2002 and back to wholesale status in 2003.

Finally, as shown in the bottom right in Table 2, panel B, most banks did not engage in M&As, but most of overall industry liquidity is created by recently merged institutions. This result is purely driven by large banks; among medium and small banks, institutions that did not engage in recent merger activity create more liquidity than those that did. This explains why liquidity creation by recently merged banks increased in almost every year, whereas liquidity creation remained relatively constant over the sample period for banks that did not engage in M&As.

3.3 Characteristics of banks that create the most and least liquidity

We next examine the characteristics of banks that create the most and least liquidity. In each size class, we split banks into "high liquidity creators" and "low liquidity creators" based on our preferred "cat fat" measure. We define high and low liquidity creators as those in the top 25% and bottom 25%, respectively, based on (1) overall liquidity creation; (2) liquidity creation divided by *GTA*; and (3) liquidity creation divided by equity.

The top, middle, and bottom parts of panel C in Table 2 show the results based on overall liquidity creation (*LC*), *LC/GTA*, and *LC/EQ*, respectively. Each part shows the average amount of liquidity created by high and low liquidity creators, and some key characteristics (BHC status, wholesale versus retail orientation, and merger status) of these banks. For example, among large banks, each of the high liquidity creators on average created $36 billion in liquidity. Splitting these high liquidity creators by BHC status, we find that 99% of these banks are MBHC members, and 1% are OBHC members. Similarly, 25% have a wholesale orientation, while 25% are retail banks; 74% engaged in recent M&A activity, while 26% were not involved in recent M&A activity.

Several findings are noteworthy. First, not surprisingly, high liquidity creators create substantially more liquidity than low liquidity creators in each size class. What may be surprising, however, is just how small the numbers are for the low liquidity creators. In particular, the bottom 25% of small banks in terms of overall liquidity creation create slightly negative liquidity. This raises the question of whether these institutions should still be considered to be banks. To address this question, it is important to recall that banks perform two central roles in the economy, liquidity creation and risk transformation. While these banks may not create liquidity, they may still provide valuable risk-transformation services, although a deeper investigation of this issue is beyond the scope of this article.

Second, MBHC members tend to create the most liquidity in every size class by every measure of liquidity creation. In all cases, OBHC members and independent banks tend to be more prevalent among the low liquidity creators.

Third, based on overall liquidity creation, retail banks tend to be high liquidity creators in every size class. Maybe surprisingly, we find opposite results when we split banks based on liquidity creation divided by *GTA* and equity. One explanation may be that retail banks tend to be the largest banks in each size class. While these banks create substantial amounts of liquidity, they create far less liquidity per dollar of assets or equity. Wholesale banks tend to be low liquidity creators in every size class.

Fourth, a far more diverse picture arises when we look at banks' M&A history. Among large banks, high liquidity creators tend to be banks with recent M&A activity, while low liquidity creators are approximately evenly distributed among those that did and those that did not engage in M&As. Since most of the small banks did not engage in recent M&As, it is not surprising that among these banks, most of both the high and low liquidity creators had no recent M&A activity. However, it is clear that small banks that did engage in M&As in the prior three years are better represented among the high liquidity creators. The medium bank pattern falls somewhere in between the patterns for large and small banks.

3.4 Value implications of bank liquidity creation

We next investigate the value implications of bank liquidity creation. If liquidity creation creates a net surplus to be shared between the bank, its borrowers, and its depositors, then liquidity creation should be positively associated with the market value of the bank or its holding company. To examine this issue, we focus on banks that are individually traded or part of a traded bank holding company. For the purposes of this analysis, we include listed independent banks and OBHCs, and we aggregate the liquidity creation of all the banks in a listed MBHC. To ensure that any relationship between liquidity creation and value is likely to be due to the liquidity created by our sample banks, we exclude holding companies in which these banks account for less than 90% of holding company assets.[23] Imposing this restriction reduces our sample from 3686 to 3223 bank-year observations.

Since we are not aware of any theories that predict a causal link between liquidity creation and value, we focus on correlations. In particular, we present correlations between liquidity creation and value, where liquidity creation is measured by the dollar amount of liquidity creation and liquidity creation divided by *GTA* and equity (all calculated using our "cat fat" measure), and value is measured as the *Market-to-Book ratio* and the *Price-Earnings ratio* (based on earnings before and after extraordinary items).

Table 3 contains the results. As shown, the dollar amount of liquidity creation and liquidity creation divided by *GTA* and equity are all significantly positively correlated with the market-to-book ratio, with correlations between 0.115 and 0.164. The correlations with the price-earnings ratio (based on earnings before

[23] The findings are similar if we instead impose an 85% or a 95% cutoff. If we do not impose any restriction, results based on the market-to-book ratio are unchanged, but the findings based on the price-earnings ratio are somewhat weaker (significant in only two of six cases).

Table 3
Value implications of liquidity creation

	N	Market-to-Book ratio	Price-Earnings ratio (based on earnings before extraordinary items)	Price-Earnings ratio (based on earnings after extraordinary items)
Liquidity creation: *LC* ($)	3223	0.115	0.042	0.042
		(0.00)***	(0.02)**	(0.02)**
Liquidity creation: *LC/GTA*	3223	0.151	0.041	0.042
		(0.00)***	(0.02)**	(0.02)**
Liquidity creation: *LC/EQ*	3223	0.164	0.024	0.025
		(0.00)***	(0.18)	(0.16)

This table shows correlations between liquidity creation and valuation of listed banks and bank holding companies. For independent banks, these are direct correlations between the amount of liquidity created by the bank and its valuation. For multibank holding companies, we aggregate liquidity created by all the banks in the holding company. For one-bank holding companies and multibank holding companies we require that the total assets of the banks comprise at least 90% of the total assets of the bank holding company, and calculate correlations between total bank liquidity created and the valuation of the holding company. The dollar amount of liquidity creation (*LC*) is calculated using our preferred "cat fat" liquidity creation measure as defined in Table 1. *GTA* equals total assets plus the allowance for loan and lease losses and the allocated transfer risk reserve (a reserve for certain foreign loans). EQ is total equity capital. The valuation measures used are the market-to-book ratio and the price-earnings ratio. The market-to-book ratio is defined as the market value of equity measured as of 31 December divided by the book value of equity measured as of the previous fiscal year end. The book value of equity is defined as the Compustat book value of stockholder's equity, plus balance sheet deferred taxes and investment tax credit, minus the book value of preferred stock. All accounting data are winsorized at the 1% and 99% level to reduce the impact of outliers. As in Fama and French (1993), we use the redemption, liquidation, or par value (in that order) to estimate the value of preferred stock. The price-earnings ratio is defined as the share price as of 31 December divided by earnings (before and after extraordinary items) per share measured as of the previous fiscal year end. p-values are in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

and after extraordinary items) are also all positive, but they are smaller in magnitude, and are significant in only four of six cases. These results suggest that banks that create more liquidity are valued more highly by investors.

4. Analytical Framework

We next turn to our third main goal of analyzing the effect of bank capital on liquidity creation. In this section, we describe our regression framework and explain our regression variables. In Section 5, we present our empirical results, and in Section 6, we examine the robustness of our results.

Before we present our regression framework, we note that the theories suggest a causal link between capital and liquidity creation. According to the "financial fragility-crowding out" hypothesis, the effect of capital on liquidity creation is negative, and according to the "risk absorption" hypothesis the effect is positive. The negative effect of capital on liquidity creation as suggested by Diamond and Rajan (2000, 2001), i.e., the financial fragility effect, only arises if deposit insurance coverage is incomplete. Deposit insurance is indeed incomplete for banks in all three of our size classes over our sample period: most banks fund themselves partly with uninsured deposits and with overnight federal funds purchased, another funding source that can run on the bank.[24]

[24] For example, as of 2003, large banks fund 21.4% and 7.5% of their *GTA* with uninsured deposits and overnight federal funds purchased, respectively. For medium banks, the corresponding figures are 24.3% and 5.7%, respectively, while for small banks, the figures are 19.8% and 2.2%, respectively.

In practice, capital and liquidity creation are to some extent jointly determined. To mitigate this potential endogeneity problem, our exogenous variables are lagged values, as discussed above. Nonetheless, this may not be sufficient. We therefore interpret all our regression results with care. We do not claim to establish causation in our regressions, but at a minimum, our results yield interesting correlations between capital and liquidity creation that are consistent with the theories and are robust to a variety of checks, including tests that involve instrumental variables for capital.

4.1 Regression framework

To examine whether the "financial fragility-crowding out" effect or the "risk absorption" effect empirically dominates, we use panel datasets on large, medium, and small banks from 1993 to 2003. We regress the dollar amount of bank liquidity creation (calculated using our four liquidity creation measures) divided by *GTA* on the lagged equity capital ratio while controlling for other factors that may affect bank liquidity creation. Normalization by *GTA* is necessary to make the dependent variables meaningful and comparable across banks and to avoid giving undue weight to the largest institutions. Use of dollar amounts of liquidity creation without normalization would primarily amount to a regression of bank size on capital and other exogenous variables because banks differ so greatly in size even within each size class.

Our control variables include bank risk, bank size, BHC membership, merger and acquisition history, and local market competition and economic environment, as explained in detail below. We include bank fixed effects to account for average differences over time across banks that are not captured by the other exogenous variables and to reduce correlations across error terms. Time fixed effects are added to control for average differences in liquidity creation across years that are not captured by the other exogenous variables, and to reduce serial correlation problems. All regressions are estimated with robust standard errors, clustered by bank, to control for heteroskedasticity, as well as possible correlation among observations of the same bank in different years.

Table 4 gives descriptions and summary statistics for the exogenous variables. All financial values are expressed in real 2003 dollars using the implicit GDP price deflator.[25] The exogenous variables are lagged values created using annual data averaged over the three years prior to observation of the dependent variables to reduce potential endogeneity problems, as lagged values are more likely to reflect earlier decisions.[26] The use of three-year averages, rather than a single lagged year, also reduces the effects of short-term fluctuations and problems with the use of accounting data. As well, portfolio changes take time to occur and likely reflect decisions made on the basis of historical experience, so

[25] We obtain similar results if we express all values in real 1993 dollars.

[26] Exceptions are two of our risk measures, which are calculated using data from the previous twelve quarters (see Section 4.3).

Table 4
Definitions and summary statistics for exogenous variables

Variable	Definition	Mean for all banks	Mean for large banks	Mean for medium banks	Mean for small banks
Bank capital ratio					
EQRAT	Equity capital ratio: total equity capital as a proportion of *GTA*, where *GTA* equals total assets plus the allowance for loan and lease losses and the allocated transfer risk reserve (a reserve for certain foreign loans)	0.10	0.08	0.09	0.10
Bank risk					
EARNVOL	Standard deviation of the bank's quarterly return on assets measured over the previous twelve quarters, multiplied by 100	0.12	0.12	0.11	0.12
CREDITRISK	Credit risk measure: calculated as the bank's Basel I risk-weighted assets and off-balance sheet activities divided by *GTA*. To reduce multicollinearity, this variable is orthogonalized in all analyses	0.61	0.72	0.66	0.61
ZSCORE	Distance to default: measured as the bank's return on assets plus the equity capital/*GTA* ratio divided by the standard deviation of the return on assets. To reduce multicollinearity, this variable is orthogonalized in all analyses	1.43	1.24	1.52	1.43
Bank size					
Ln(GTA)	Natural log of *GTA*	11.61	16.18	14.30	11.44
Bank holding company status					
D-MBHC	A dummy that equals 1 if the bank has been part of a multibank holding company over the past three years	0.44	0.95	0.81	0.42
D-OBHC	A dummy that equals 1 if the bank has been part of a one-bank holding company over the past three years	0.34	0.02	0.09	0.35
Mergers and acquisitions					
D-BANK-MERGE	A dummy that equals 1 if the bank was involved in one or more mergers over the past three years, combining the charters of two or more banks	0.09	0.64	0.43	0.07
D-DELTA-OWN	A dummy that equals 1 if the bank was acquired in the last three years, indicated by a change in top-tier holding company with no change in charter	0.09	0.06	0.10	0.09

Local market competition					
HERF	A bank-level Herfindahl index based on bank and thrift deposits (the only variable for which geographic location is publicly available). We first establish the Herfindahl index of the markets in which the bank has deposits and then weight these market indices by the proportion of the bank's deposits in each of these markets	0.21	0.15	0.16	0.21
SHARE-ML	Share of market bank and thrift deposits held by medium and large banks (*GTA* exceeding $1 billion)	0.32	0.58	0.56	0.31
Local market economic environment					
Ln(POP)	Natural log of weighted average population in all markets in which a bank has deposits, using the proportion of deposits held by a bank in each market as weights	11.90	14.30	13.81	11.79
Ln(DENSITY)	Weighted average population density (natural log of population per square mile) in all markets in which a bank has deposits, using the proportion of deposits held by a bank in each market as weights	4.68	6.50	6.15	4.60
INC-GROWTH	Weighted average income growth in all markets in which a bank has deposits, using the proportion of deposits held by a bank in each market as weights	0.05	0.05	0.05	0.05
Fixed effects					
Time fixed effects	Set of dummies for all but one year				
Bank fixed effects	Set of dummies for all but one bank				

The exogenous variables are created using annual data and are three-year lagged averages (i.e., the average of three years prior to observation of the dependent variable), except for the risk measure, which is calculated using data on the previous twelve quarters. All of the annual lagged values are merger adjusted; the bank capital ratio and size are pro forma values, the mergers and acquisitions dummies simply take a value of 1 or 0 based on the combined experience of the banks in the case of mergers or acquisitions, and the local market competition and environment variables are weighted averages for the merging banks using their *GTA* values in constructing the weights. Sample period: 1993–2003. Sample means are provided for all banks, large banks (*GTA* exceeding $3 billion), medium banks (*GTA* $1 billion–$3 billion), and small banks (*GTA* up to $1 billion). All financial values are expressed in real 2003 dollars using the implicit GDP price deflator.
Data sources: Bank Call Reports, Bank Holding Company Y-9 reports, FDIC Summary of Deposits, NIC Database, Bureau of Economic Analysis, and U.S. Census Bureau.

three years of data may more accurately reflect the inputs into liquidity creation decisions.[27] All of the annual lagged values are merger adjusted. We collect information from the Federal Reserve Board's National Information Center (NIC) database on a bank's prior M&As, and use it to construct historical pro forma values.

4.2 Variable descriptions

The key exogenous variable is the lagged capital ratio. For our main analysis, we use *EQRAT*, the ratio of equity to *GTA*. Equity meets the most straightforward, narrow definition of capital as funds that cannot be easily withdrawn. *GTA* is the simplest measure of bank size, although it excludes off-balance sheet activities. *GTA* equals total assets plus the allowance for loan and lease losses and the allocated transfer risk reserve—two reserves held for potential credit losses—so that the full value of the loans financed and liquidity created by the bank on the asset side are included. In Section 6, we perform two robustness checks on the capital ratio. First, we replace *EQRAT* with an alternative capital ratio. Second, realizing that to some extent, a bank chooses its capital ratio, we use an instrumental variable approach to resolve any potential endogeneity problems.

We control for bank risk using three risk measures.[28] The first measure is earnings volatility (as in Berger et al. 2008, and Laeven and Levine forthcoming). *EARNVOL* is measured as the standard deviation of the bank's return on assets over the previous twelve (minimum: eight) quarters. The second measure is a bank's credit risk, a key risk of banks. *CREDITRISK* is calculated as a bank's Basel I risk-weighted assets and off-balance sheet activities divided by *GTA*. The third risk measure is the z-score, which indicates a bank's distance from default (e.g., Boyd, Graham, and Hewitt 1993). *ZSCORE* is measured as a bank's return on assets plus the equity capital/*GTA* ratio divided by the standard deviation of the return on assets. A higher z-score indicates that a bank is more stable. It is important to appropriately control for bank risk because a primary reason why banks hold capital is to absorb risk. The inclusion of risk measures helps to isolate the role of capital in supporting the liquidity creation function of banks from the role of capital in supporting banks' function as risk transformers. It is standard practice in the literature to include risk measures one at a time.[29] Nonetheless, we include all three risk measures in every regression in order to capture all of the information in all three measures in a single specification. However, because all three measures

[27] Using one-year lagged values weakens the significance of the results for large banks, but leaves our results for medium and small banks qualitatively unchanged.

[28] Since our analyses are performed at the bank level, risk measures typically used at the BHC level (including stock return volatility, bond ratings, and beta) cannot be used.

[29] See, e.g., Brockman and Turtle (2003); Acharya, Bharath, and Srinivasan (2007); John, Litov, and Yeung (2008); and Kadan and Swinkels (2008).

assess the same underlying unobservable variable (risk), there is a serious multicollinearity problem associated with introducing them simultaneously. We deal with this problem by orthogonalizing two of the risk measures.[30] In all of the analyses reported in the article, we include *EARNVOL*, orthogonalized *CREDITRISK*, and orthogonalized *ZSCORE*. (For simplicity, we use the terms *CREDITRISK* and *ZSCORE* instead of orthogonalized *CREDITRISK* and orthogonalized *ZSCORE* throughout.) Since our approach is a departure from the standard approach of introducing risk measures one at a time, we also run the base regressions by alternatively including these three risk measures individually. The results are qualitatively similar to those reported in the article and are available upon request.

To control for bank size, we include the natural log of bank size, *Ln*(*GTA*), in every regression, as well as running the regressions separately for large, medium, and small banks. The natural log is used for all of the continuous exogenous variables that may take on large values to avoid potential specification distortions, given that the dependent variables are generally in the [0,1] interval.[31]

We control for the bank's bank holding company (BHC) status with two variables: *D-MBHC*, a dummy variable that equals one if the bank has been part of a multibank bank holding company (MBHC) in any of the past three years and zero otherwise, and *D-OBHC*, a dummy variable that equals one if the bank has been part of a one-bank holding company (OBHC) in any of the past three years and zero otherwise. BHCs and other banks in the same BHC may serve as internal capital markets to provide capital in times of stress. This view is supported by both regulation and the literature.[32]

We also control for the bank's merger and acquisition history. The *D-BANK-MERGE* and *D-DELTA-OWN* dummies indicate whether a bank was involved in a merger or acquisition over the past three years, where a merger is defined as the combination of bank charters into an institution with a single set of books, and an acquisition is defined as a case in which the bank's top-tier holding company changed with no change in charter status. Controlling for mergers and acquisitions is important because banks often substantially alter their lending behavior following such events.

To construct controls for local market competition and economic environment, we define the local market as the Metropolitan Statistical Area (MSA)

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[30] We regress *CREDITRISK* on *EARNVOL*, *ZSCORE*, and all of the control variables. The residuals of this regression represent the variation in *CREDITRISK* not captured by *EARNVOL*, *ZSCORE,* or the other explanatory variables. We follow a similar procedure for *ZSCORE.*

[31] For example, based on our preferred "cat fat" measure, liquidity creation divided by *GTA* (our dependent variable) is in the [0,1] interval 90.5% of the time.

[32] U.S. regulations require BHCs to be a source of strength for the banks they own and require other banks in the same BHC to cross-guarantee the other bank affiliates. Empirical research finds, for example, that bank loan growth depends on the BHC (e.g., Houston, James, and Marcus 1997).

or non-MSA county in which the offices are located.[33] For banks with offices in more than one local market, we use weighted averages across these markets, using the proportion of the bank's deposits in each of these markets as the weights.[34] To control for local market competition, we include *HERF*, the Herfindahl index of concentration for the market or markets in which the bank is present. We base *HERF* on the market shares of both banks and thrift institutions, given that thrifts compete vigorously with banks for deposits. We also include *SHARE-ML*, the local market share of medium and large institutions, to allow for the possibility that banks of different sizes may compete differently. It is important to control for local market competition because various studies have shown that market concentration affects credit availability (e.g., Petersen and Rajan 1995) and that the loan portfolios of large and small banks are markedly different (e.g., Berger et al. 2005). Hence, competition likely affects liquidity creation through both the amount and types of loans a bank extends and the way it funds its activities.[35] To control for local market economic conditions, we include the log of population *Ln(POP)*, the log of population density *Ln(DENSITY)*, and income growth *INC-GROWTH*.

5. Regression Results

In this section, we present our regression results. We first present our main results and find that the relationship between capital and liquidity creation differs for large, medium, and small banks. We then investigate why the results differ by size class using the components of liquidity creation. In all cases, we examine whether the findings are consistent with the economic intuition discussed earlier. In Section 6, we conduct a number of robustness checks.

Before proceeding, we note the important distinction between the liquidity creation weight on capital and the regression coefficient on lagged capital. We assign a weight of $-\frac{1}{2}$ to equity when forming our liquidity creation measures, the dependent variables in the regressions. This does not imply that when we regress the dollar amount of liquidity creation (normalized by *GTA*) on the lagged equity ratio, *EQRAT*, the coefficient on *EQRAT* should necessarily be negative or close to -0.5. Rather, the measured effect depends on bank behavior. For example, if banks with more lagged equity capital extend significantly more illiquid loans and hold significantly fewer liquid assets than banks with lower levels of capital, we may find a positive association between lagged capital and liquidity creation.[36]

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[33] In some cases, we use New England County Metropolitan Areas (NECMAs) in place of MSAs, but for convenience, we use the term MSA to cover both MSAs and NECMAs.

[34] We use shares of deposits because this is the only banking service for which geographic location is publicly available.

[35] We obtain similar regression results if we exclude the local market competition variables.

[36] A potential concern about our regression specification is that current bank equity is included in our dependent variable (liquidity creation divided by *GTA*), while the lagged equity ratio is our key exogenous variable. To

5.1 The net effect of capital on liquidity creation for large, medium, and small banks

Panels A, B, and C of Table 5 contain the regression results for large banks (*GTA* exceeding \$3 billion), medium banks (*GTA* \$1 billion—\$3 billion), and small banks (*GTA* up to \$1 billion), respectively. All of our regressions include the full set of control variables and have time and bank fixed effects, but the results are similar if we control only for size and include fixed effects (not shown for brevity's sake).

The results in panel A of Table 5 suggest that for large banks, the relationship between capital and liquidity creation is positive and significant when liquidity creation includes off-balance sheet activities, i.e., when we use our "fat" liquidity creation measures ("cat fat" or "mat fat"). The magnitude of the coefficient on the lagged equity capital ratio in the "cat fat" regression, 1.146, suggests that large banks with a 1 percentage point higher equity capital ratio for the prior three years (i.e., an increase in *EQRAT* of 0.01) create additional liquidity of over 1 percentage point of a large bank's *GTA*, which appears to be a substantial effect. Using the "nonfat" measures, capital is not significantly correlated with liquidity creation, suggesting that off-balance sheet activities constitute an important part of the effect of capital on liquidity creation for large banks. The *EQRAT* coefficients in the "cat" and "mat" specifications are of similar magnitude, suggesting that use of maturities in place of categories for loans has little impact on the measured net effect of capital.

The results for medium banks in panel B of Table 5 are mixed. For these banks, the relationship between capital and liquidity creation is positive and not significant for the "fat" measures and negative and marginally significant for the "nonfat" measures.

The results in panel C of Table 5 suggest that for small banks, the relationship between capital and liquidity creation is negative, in sharp contrast to the positive or mixed relationship found for large and medium banks. All of the coefficients on the lagged capital ratio are negative and significant at the 1% level, yielding a fairly clear result that is robust across the liquidity creation measures. Using our preferred "cat fat" measure, the magnitude of the coefficient on the lagged equity capital ratio, -0.330, suggests that small banks with a 0.01 higher *EQRAT* create less liquidity by about a third of a percentage point of their *GTA*. As for the large banks, the magnitudes of the net effect of capital on liquidity creation are similar for the "cat" and "mat" measures for small banks. However, a key difference for small banks is that the "fat" and "nonfat" magnitudes are also similar. The inclusion of off-balance sheet activities makes little difference to the net effect of capital on liquidity creation, reflecting the lesser role of these activities for small institutions.

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address this, we also construct a liquidity creation measure that excludes equity and obtain similar results (see Section 6.3).

Table 5
The effect of capital on liquidity creation

	Panel A: Regression results for large banks				Panel B: Regression results for medium banks				Panel C: Regression results for small banks			
	cat fat/ *GTA*	cat nonfat/ *GTA*	mat fat/ *GTA*	mat nonfat/ *GTA*	cat fat/ *GTA*	cat nonfat/ *GTA*	mat fat/ *GTA*	mat nonfat/ *GTA*	cat fat/ *GTA*	cat nonfat/ *GTA*	mat fat/ *GTA*	mat nonfat/ *GTA*
EQRAT	1.146	0.465	1.171	0.490	0.219	−0.438	0.260	−0.397	−0.330	−0.341	−0.394	−0.405
	(3.23)***	(1.22)	(3.19)***	(1.31)	(0.29)	(−1.83)*	(0.37)	(−1.71)*	(−7.26)***	(−8.73)***	(−9.90)***	(−11.83)***
EARNVOL	−0.129	−0.103	−0.128	−0.102	0.025	−0.034	0.037	−0.023	−0.019	−0.012	−0.013	−0.005
	(−2.48)**	(−2.24)**	(−2.32)**	(−2.16)**	(0.29)	(−1.19)	(0.38)	(−0.72)	(−3.54)***	(−2.42)**	(−2.30)**	(−1.02)
CREDITRISK	−0.018	0.013	−0.008	0.024	0.043	0.023	0.056	0.036	−0.002	−0.003	−0.021	−0.022
	(−1.03)	(1.23)	(−0.38)	(1.89)*	(1.76)*	(1.65)*	(2.12)**	(2.06)**	(−0.72)	(−1.28)	(−7.40)***	(−8.58)***
ZSCORE	0.006	0.011	0.000	0.004	0.008	0.008	0.006	0.006	−0.003	−0.003	−0.002	−0.002
	(0.82)	(2.16)**	(0.02)	(0.89)	(1.98)**	(2.43)**	(1.32)	(1.63)	(−4.82)***	(−5.18)***	(−3.51)***	(−3.61)***
Ln(GTA)	−0.018	0.013	−0.008	0.024	0.043	0.023	0.056	0.036	−0.002	−0.003	−0.021	−0.022
	(−1.03)	(1.23)	(−0.38)	(1.89)*	(1.76)*	(1.65)*	(2.12)**	(2.06)**	(−0.72)	(−1.28)	(−7.40)***	(−8.58)***
D-MBHC	0.004	−0.005	0.012	0.002	−0.004	−0.001	−0.004	−0.001	0.010	0.010	0.014	0.013
	(0.38)	(−0.96)	(1.03)	(0.30)	(−0.71)	(−0.24)	(−0.80)	(−0.34)	(5.82)***	(6.39)***	(7.83)***	(8.41)***
D-OBHC	0.090	0.099	0.099	0.109	0.021	0.026	−0.004	0.001	0.033	0.032	0.034	0.033
	(0.74)	(1.10)	(0.84)	(1.24)	(0.66)	(1.13)	(−0.12)	(0.03)	(10.82)***	(11.37)***	(10.65)***	(10.99)***
D-BANK-MERGE	0.004	−0.005	0.012	0.002	−0.004	−0.001	−0.004	−0.001	0.010	0.010	0.014	0.013
	(0.38)	(−0.96)	(1.03)	(0.30)	(−0.71)	(−0.24)	(−0.80)	(−0.34)	(5.82)***	(6.39)***	(7.83)***	(8.41)***
D-DELTA-OWN	−0.026	0.021	−0.001	0.046	−0.097	−0.053	−0.106	−0.062	0.019	0.015	0.020	0.016
	(−0.50)	(0.53)	(−0.02)	(1.06)	(−2.21)**	(−1.98)**	(−2.11)**	(−1.85)*	(3.90)***	(3.42)***	(3.84)***	(3.30)***
HERF	−0.027	−0.241	0.107	−0.106	−0.270	−0.176	−0.113	−0.020	0.032	0.028	0.008	0.005
	(−0.12)	(−1.31)	(0.45)	(−0.57)	(−1.89)*	(−1.45)	(−0.68)	(−0.15)	(2.15)**	(2.13)**	(0.52)	(0.34)
SHARE-ML	−0.026	0.021	−0.001	0.046	−0.097	−0.053	−0.106	−0.062	0.019	0.015	0.020	0.016
	(−0.50)	(0.53)	(−0.02)	(1.06)	(−2.21)**	(−1.98)**	(−2.11)**	(−1.85)*	(3.90)***	(3.42)***	(3.84)***	(3.30)***
Ln(POP)	0.803	−0.361	0.665	−0.498	−0.318	−0.372	−0.249	−0.303	0.080	0.039	0.035	−0.006
	(1.42)	(−1.26)	(1.10)	(−1.58)	(−1.11)	(−2.07)**	(−0.77)	(−1.31)	(4.09)***	(2.24)**	(1.78)*	(−0.31)
Ln(DENSITY)	−0.089	−0.020	−0.043	0.026	−0.015	−0.022	−0.019	−0.026	0.017	0.015	0.010	0.008
	(−1.50)	(−0.95)	(−0.62)	(0.80)	(−0.29)	(−0.56)	(−0.35)	(−0.63)	(2.64)***	(2.60)***	(1.48)	(1.25)

INC-GROWTH	0.803	−0.361	0.665	−0.498	−0.318	−0.372	−0.249	−0.303	0.080	0.039	0.035	−0.006
	(1.42)	(−1.26)	(1.10)	(−1.58)	(−1.11)	(−2.07)**	(−0.77)	(−1.31)	(4.09)***	(2.24)**	(1.78)*	(−0.31)
Constant	−0.149	−0.143	−0.051	−0.045	−0.332	−0.160	−0.415	−0.242	0.053	0.041	0.318	0.306
	(−0.42)	(−0.60)	(−0.13)	(−0.17)	(−0.77)	(−0.53)	(−0.87)	(−0.66)	(1.32)	(1.14)	(7.76)***	(8.04)***
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1804	1804	1804	1804	2132	2132	2132	2132	80,062	80,062	80,062	80,062
Adjusted *R*-squared	0.82	0.85	0.81	0.85	0.76	0.90	0.72	0.88	0.89	0.89	0.88	0.87

This table presents our main regression results. The dependent variable is the dollar amount of liquidity a bank has created, calculated using the four liquidity creation measures as defined in Table 1, normalized by *GTA*. *GTA* equals total assets plus the allowance for loan and lease losses and the allocated transfer risk reserve (a reserve for certain foreign loans). Panels A, B, and C contain the results for large banks (*GTA* exceeding $3 billion), medium banks (*GTA* $1 billion–$3 billion), and small banks (*GTA* up to $1 billion), respectively.

EQRAT is the equity capital ratio (total equity capital as a proportion of *GTA*). *EARNVOL* is the standard deviation of the bank's quarterly return on assets measured over the previous twelve quarters, multiplied by 100. *CREDITRISK* is a credit risk measure, calculated as the bank's Basel I risk-weighted assets and off-balance sheet activities divided by *GTA*. This variable is orthogonalized to avoid multicollinearity. *ZSCORE* is the distance to default, measured as the bank's return on assets plus the equity capital/*GTA* ratio divided by the standard deviation of the return on assets. This variable is orthogonalized to avoid multicollinearity. *Ln(GTA)* is the log of *GTA*. *D-MBHC* and *D-OBHC* are dummy variables that equal 1 if the bank has been part of a multibank holding company or a one-bank holding company over the prior three years. *D-BANK-MERGE* is a dummy that equals 1 if the bank was involved in one or more mergers over the past three years, combining the charters of two or more banks. *D-DELTA-OWN* is a dummy that equals 1 if the bank was acquired in the last three years, indicated by a change in top-tier holding company with no change in charter. *HERF* is a bank-level Herfindahl index based on bank and thrift deposits (the only variable for which geographic location is publicly available). We first establish the Herfindahl index of the markets in which the bank has deposits and then weight these market indices by the proportion of the bank's deposits in each of these markets. *SHARE-ML* is the share of market bank and thrift deposits held by medium and large banks (*GTA* exceeding $1 billion). *Ln(POP)* is the natural log of weighted average population in all markets in which a bank has deposits, using the proportion of deposits held by a bank in each market as weights. *Ln(DENSITY)* is the weighted average population density (natural log of population per square mile) in all markets in which a bank has deposits, using the proportion of deposits held by a bank in each market as weights. *INC-GROWTH* is the weighted average income growth in all markets in which a bank has deposits, using the proportion of deposits held by a bank in each market as weights. All regressions are run with both time fixed effects and bank fixed effects.

The sample period is 1993–2003. *t*-statistics based on robust standard errors clustered by bank are in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

In sum, we find that for large banks, capital and liquidity creation are positively correlated when we use measures that include off-balance sheet activities, while this relationship is insignificant when we exclude those activities. For small banks, capital and liquidity creation are negatively correlated using all of our measures, while for medium banks, the relationship is mixed. Thus, the data suggest that, consistent with our economic intuition, the "risk absorption" hypothesis dominates for large banks when off-balance sheet activities are included and the "financial fragility-crowding out" hypothesis strongly dominates for small banks. The two effects are largely offsetting for medium banks. We next investigate what drives these differences.

5.2 Why is the net effect of capital on liquidity creation different by bank size class?

To understand more deeply why the relationship between capital and liquidity creation differs by bank size class, we examine the relationship between capital and the individual components of liquidity creation (e.g., liquid, semiliquid, and illiquid assets). Specifically, we use the individual components based on our "cat fat" liquidity creation measure normalized by *GTA* as dependent variables in our regressions.

Panels A, B, and C of Table 6 show the coefficients on *EQRAT* from these regressions for large, medium, and small banks, respectively. All of the control variables from the full specification are included in these regressions, but are not shown in the interest of brevity. Importantly, since liquidity creation equals the weighted sum of the individual components (using the ½ , 0, and −½ liquidity creation weights discussed above), the weighted sums of the *EQRAT* coefficients on the individual liquidity creation components in Table 6 equal the coefficient on *EQRAT* using the "cat fat" measure in Table 5.[37] Therefore, the *EQRAT* coefficients in the individual component regressions help us understand which components of liquidity creation yield the different results for large, medium, and small banks.

The results in panel A of Table 6 suggest that for large banks, lagged capital is positively related with liquidity creation on the asset side of the balance sheet, as well as off the balance sheet. Banks with higher lagged capital ratios have significantly more illiquid assets, fewer liquid assets, and more illiquid guarantees. These positive effects of capital are partially offset by the fact that large banks with higher lagged capital ratios have significantly higher capital ratios in the current period (i.e., the coefficient on *EQRAT* in the equity/*GTA* regression is positive and significant). Thus, the positive relationship between lagged capital and liquidity creation calculated using our "cat fat" measure in panel A of Table 4 is the net result of the positive relationship between

[37] For example, for large banks, $\frac{1}{2} * 0.356 + 0 * 0.186 + (-\frac{1}{2}) * (-0.541) + \frac{1}{2} * 0.191 + 0 * (-0.276) + (-\frac{1}{2}) * (-0.195) + (-\frac{1}{2}) * 0.353 + \frac{1}{2} * 1.353 + 0 * (-0.664) + (-\frac{1}{2}) * 0.000 + (-\frac{1}{2}) * (-0.009) = 1.146$.

Table 6
The effect of capital on the components of liquidity creation

	Assets/*GTA*			Liabilities/*GTA*			Equity/*GTA*	Guarantees/*GTA*			Derivatives/*GTA*
	Illiquid	Semiliquid	Liquid	Liquid	Semiliquid	Illiquid	Illiquid	Illiquid	Semiliquid	Liquid	Liquid
Weight	½	0	−½	½	0	−½	−½	½	0	−½	−½
Panel A: Regression results for large banks											
EQRAT	0.356	0.186	−0.541	0.191	−0.276	−0.195	0.353	1.353	−0.664	0.000	−0.009
	(1.77)*	(1.42)	(−2.85)***	(0.58)	(−1.41)	(−0.99)	(2.69)***	(2.19)**	(−1.70)*	(0.20)	(−0.87)
Observations	1804	1804	1804	1804	1804	1804	1804	1804	1804	1804	1774
Adjusted R-squared	0.88	0.85	0.84	0.85	0.87	0.80	0.70	0.76	0.74	0.44	0.34
Panel B: Regression results for medium banks											
EQRAT	0.097	0.000	−0.097	−0.506	−0.113	0.083	0.480	1.304	0.043	0.000	−0.010
	(0.43)	(0.00)	(−0.44)	(−2.21)**	(−0.46)	(1.25)	(4.28)***	(1.02)	(0.93)	(0.28)	(−1.59)
Observations	2132	2132	2132	2132	2132	2132	2132	2132	2132	2132	2132
Adjusted R-squared	0.76	0.90	0.72	0.88	0.88	0.75	0.89	0.94	0.92	0.90	0.89
Panel C: Regression results for small banks											
EQRAT	−0.003	−0.153	0.156	−0.184	−0.161	−0.018	0.357	0.023	−0.001	0.001	0.000
	(−0.07)	(−6.60)***	(4.40)***	(−8.01)***	(−5.90)***	(−3.25)***	(21.02)***	(0.83)	(−0.22)	(1.53)	(0.35)
Observations	80,062	80,062	80,062	80,062	80,062	80,062	80,062	80,062	80,062	80,062	78,595
Adjusted R-squared	0.91	0.89	0.86	0.88	0.87	0.73	0.84	0.84	0.54	0.20	0.36

This table presents regression results. The dependent variables are the dollar amounts of the individual liquidity creation components normalized by *GTA*. The dollar amount of liquidity created is calculated using our preferred "cat fat" liquidity creation measure as defined in Table 1. *GTA* equals total assets plus the allowance for loan and lease losses and the allocated transfer risk reserve (a reserve for certain foreign loans).

Panels A, B, and C contain the results for large banks (*GTA* exceeding $3 billion), medium banks (*GTA* $1 billion–$3 billion), and small banks (*GTA* up to $1 billion), respectively. All panels show only the coefficients on *EQRAT* (total equity capital as a proportion of *GTA*) in the interest of parsimony, although the regressions include all the exogenous variables from the full specification as defined in Table 4. All regressions are run with both time fixed effects and bank fixed effects.

The sample period is 1993–2003. t-statistics based on robust standard errors clustered by bank are in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

lagged capital and assets and illiquid guarantees being larger than the negative relationship with current capital. The insignificant relationship between lagged capital and liquidity creation calculated using the "cat nonfat" measure in panel A of Table 4 occurs because the positive relationship between lagged capital and illiquid guarantees is excluded—the positive relationship between lagged capital and assets approximately offsets the negative relationship with current capital.

The findings in panel A of Table 6 are also consistent with the economic intuition that the "risk absorption" effect is relatively strong for large banks. Higher capital allows large banks to bear significantly more portfolio risk, and the data suggest that they do so. Large banks with higher capital hold more risky illiquid assets such as commercial loans and risky illiquid guarantees such as loan commitments, and fewer relatively safe liquid assets such as treasuries.

Panel B of Table 6 suggests very different effects for medium banks. Banks with higher lagged capital ratios tend to have fewer liquid liabilities. The negative relationship between lagged capital and liquid liabilities approximately offsets the positive relationship between lagged capital and current capital, yielding the overall insignificant effect for our "cat fat" measure.

Panel C of Table 6 reveals that similar to large and medium banks, small banks with higher lagged capital ratios have significantly higher capital ratios in the current period. However, in stark contrast to large banks, for small banks, capital is negatively related with liquidity creation on the asset and liability sides of the balance sheet, and essentially unrelated to liquidity creation off the balance sheet. Small banks with higher lagged capital ratios have significantly more liquid assets and fewer liquid liabilities. Thus, the effect of lagged capital is consistently negative for small banks, as opposed to the positive effect for large banks, because the negative effect on current capital is augmented by negative effects of capital on the asset and liability sides, and is not offset by a positive effect off the balance sheet.[38]

The results in panel C of Table 6 are also consistent with the economic intuition that the "financial fragility-crowding out" effect is relatively strong for small banks. On the asset side, lagged capital is not positively related with illiquid assets, but instead is positively related with liquid assets. This is consistent with the spirit of the financial fragility arguments put forth in Diamond and Rajan (2000, 2001). Capital reduces the financial fragility needed to commit to monitoring its borrowers. As a result, banks with higher lagged capital ratios may invest more in liquid assets, rather than increasing their loans. On the liability side, lagged capital is negatively related to liquid liabilities, consistent with the "crowding out" of transactions deposits as in Gorton and Winton (2000).

[38] Lagged capital also has a negative effect on illiquid liabilities (which enhances liquidity creation), but the effect is small.

6. Robustness Issues

In Section 5, we found that, based on our preferred "cat fat" measure of liquidity creation, the relationship between capital and liquidity creation is positive and significant for large banks (when off-balance sheet activities are included), insignificant for medium banks, and negative and significant for small banks. We now examine the robustness of these main findings to (1) using an alternative method to measuring off-balance sheet bank liquidity creation; (2) using an alternative way of establishing which assets are securitizable; (3) excluding equity from the liquidity creation measure; (4) using an alternative capital ratio; (5) splitting the sample by bank holding company status, wholesale versus retail orientation, and merger status; and (6) using an instrumental variable approach. We show that our main results are qualitatively unchanged.

6.1 Using an alternative method to measuring off-balance sheet liquidity creation

Our liquidity creation measures are based on the ease, cost, and time for customers to obtain liquid funds from the bank, and the ease, cost, and time for banks to dispose of their obligations in order to meet these liquidity demands. An alternative would be to use the probability or frequency with which the bank or customers actually liquefy the items and obtain liquid funds. We argue that the ability or option to obtain funds when needed or desired is more important than the actual drawdown frequency. This is also what the theories suggest: banks create liquidity on the balance sheet because they give depositors a liquid claim to their funds (i.e., the option to withdraw funds when needed) instead of forcing them to hold illiquid loans directly (e.g., Diamond and Dybvig 1983). Similarly, banks create liquidity off the balance sheet through guarantees that allow customers the option to draw down liquid funds when needed (e.g., Kashyap, Rajan, and Stein 2002).

Despite our reservations, we construct a liquidity creation measure that incorporates the frequency with which customers obtain liquid funds on off-balance sheet guarantees. Our alternative liquidity creation measure is identical to our "cat fat" measure, except that we multiply the dollar amount of illiquid off-balance sheet guarantees by 0.30, the observed frequency of drawdown as documented in recent research (Sufi 2007).[39]

Using this alternative "cat fat" measure, we find that liquidity creation of the banking sector is about one-third lower than using our preferred "cat fat" measure in every year and amounts to $1.869 trillion in 2003 (not shown for brevity). The overall pattern of liquidity creation, however, is fairly similar to the "cat fat" pattern.

In panel A of Table 7, we regress the dollar amount of liquidity creation using this alternative "cat fat" measure normalized by *GTA* on *EQRAT* and

[39] Sufi (2007) uses data on letters of credit and loan commitments over 1996–2003, which corresponds closely with our sample period, and finds that conditional on having a letter of credit or a loan commitment, the probability of drawdown over this time period was approximately 30% in every year.

Table 7
The effect of capital on liquidity creation based on three alternative methods of measuring liquidity creation

	Regression results based on a "cat fat" liquidity creation measure which								
	Panel A: Measures off-balance sheet liquidity creation differently			Panel B: Uses an alternative way to establishing which assets are securitizable			Panel C: Excludes equity		
	Large banks *LC/GTA*	Medium banks *LC/GTA*	Small banks *LC/GTA*	Large banks *LC/GTA*	Medium banks *LC/GTA*	Small banks *LC/GTA*	Large banks *LC/GTA*	Medium banks *LC/GTA*	Small banks *LC/GTA*
EQRAT	0.672	−0.238	−0.338	1.251	0.259	−0.380	0.747	0.259	−0.212
	(1.96)*	(−0.68)	(−8.33)***	(3.58)***	(0.36)	(−8.80)***	(2.30)**	(0.36)	(−6.39)***
EARNVOL	−0.111	−0.017	−0.014	−0.147	0.019	−0.021	−0.103	0.019	−0.013
	(−2.52)**	(−0.46)	(−2.82)***	(−2.62)***	(0.21)	(−3.75)***	(−2.01)**	(0.21)	(−2.75)***
CREDITRISK	0.355	0.370	0.437	0.533	0.524	0.482	0.266	0.524	0.433
	(5.80)***	(5.39)***	(40.08)***	(5.32)***	(2.64)***	(40.09)***	(4.05)***	(2.64)***	(39.24)***
ZSCORE	0.009	0.008	−0.003	0.004	0.007	−0.003	0.009	0.007	−0.002
	(1.80)*	(2.37)**	(−5.12)***	(0.53)	(1.68)*	(−4.16)***	(1.76)*	(1.68)*	(−2.70)***
Ln(GTA)	0.004	0.029	−0.003	−0.013	0.046	−0.021	0.019	0.046	−0.019
	(0.39)	(1.81)*	(−1.11)	(−0.72)	(1.94)*	(−7.39)***	(1.71)*	(1.94)*	(−7.80)***
D-MBHC	0.075	0.034	0.014	0.053	0.014	0.016	0.079	0.014	0.014
	(0.74)	(1.67)*	(5.55)***	(0.42)	(0.44)	(5.48)***	(0.85)	(0.44)	(5.15)***
D-OBHC	0.096	0.025	0.032	0.092	0.004	0.035	0.094	0.004	0.030
	(0.98)	(1.01)	(11.31)***	(0.73)	(0.12)	(11.02)***	(1.06)	(0.12)	(10.61)***
D-BANK-MERGE	−0.003	−0.002	0.010	0.009	−0.004	0.013	−0.001	−0.004	0.012
	(−0.39)	(−0.43)	(6.25)***	(0.80)	(−0.77)	(7.51)***	(−0.11)	(−0.77)	(7.65)***
D-DELTA-OWN	−0.018	−0.002	−0.003	−0.010	0.023	−0.004	−0.014	0.023	−0.003
	(−1.27)	(−0.17)	(−2.10)**	(−0.47)	(0.76)	(−2.52)**	(−1.02)	(0.76)	(−2.28)**
HERF	−0.176	−0.206	0.029	0.121	−0.175	0.028	−0.048	−0.175	0.023
	(−0.98)	(−1.71)*	(2.15)**	(0.54)	(−1.12)	(1.86)*	(−0.28)	(−1.12)	(1.72)*
SHARE-ML	0.008	−0.066	0.016	−0.037	−0.109	0.014	0.015	−0.109	0.009
	(0.21)	(−2.21)**	(3.60)***	(−0.68)	(−2.24)**	(2.77)***	(0.36)	(−2.24)**	(1.97)**
Ln(POP)	0.035	0.017	0.006	0.070	0.007	0.008	0.006	0.007	0.008
	(1.29)	(0.61)	(1.64)	(1.17)	(0.19)	(2.10)**	(0.25)	(0.19)	(2.14)**
Ln(DENSITY)	−0.040	−0.020	0.015	−0.072	−0.008	0.012	−0.007	−0.008	0.010
	(−1.42)	(−0.49)	(2.64)***	(−1.18)	(−0.15)	(1.91)*	(−0.32)	(−0.15)	(1.75)*

INC-GROWTH	0.009	0.062	0.086	0.012	0.025	0.074	−0.043	0.025	0.056
	(0.42)	(3.44)***	(38.87)***	(0.48)	(0.99)	(30.26)***	(−1.87)*	(0.99)	(25.45)***
Constant	0.672	−0.238	−0.338	1.251	0.259	−0.380	0.747	0.259	−0.212
	(1.96)*	(−0.68)	(−8.33)***	(3.58)***	(0.36)	(−8.80)***	(2.30)**	(0.36)	(−6.39)***
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1804	2132	80,062	1804	2132	80,062	1804	2132	80,062
Adjusted R-squared	0.85	0.88	0.89	0.82	0.75	0.88	0.85	0.75	0.86

This table presents regression results. The dependent variable is *LC*/*GTA*, the dollar amount of liquidity a bank has created (calculated using alternative "cat fat" liquidity creation measures as explained below) normalized by *GTA*. *GTA* equals total assets plus the allowance for loan and lease losses and the allocated transfer risk reserve (a reserve for certain foreign loans). Panel A shows results for an alternative method to measuring off-balance sheet liquidity creation (discussed in Section 7.1). Panel B shows results for an alternative way to establishing which assets are securitizable (discussed in Section 7.2). Panel C shows results based on a liquidity creation measure which excludes equity (discussed in Section 7.3). All panels show results for large banks (*GTA* exceeding \$3 billion), medium banks (*GTA* \$1 billion–\$3 billion), and small banks (*GTA* up to \$1 billion).

EQRAT is the equity capital ratio (total equity capital as a proportion of *GTA*). *EARNVOL* is the standard deviation of the bank's quarterly return on assets measured over the previous twelve quarters, multiplied by 100. *CREDITRISK* is a credit risk measure, calculated as the bank's Basel I risk-weighted assets and off-balance sheet activities divided by *GTA*. This variable is orthogonalized to avoid multicollinearity. *ZSCORE* is the distance to default, measured as the bank's return on assets plus the equity capital/*GTA* ratio divided by the standard deviation of the return on assets. This variable is orthogonalized to avoid multicollinearity. *Ln(GTA)* is the log of *GTA*. *D-MBHC* and *D-OBHC* are dummy variables that equal 1 if the bank has been part of a multibank holding company or a one-bank holding company over the prior three years. *D-BANK-MERGE* is a dummy that equals 1 if the bank was involved in one or more mergers over the past three years, combining the charters of two or more banks. *D-DELTA-OWN* is a dummy that equals 1 if the bank was acquired in the last three years, indicated by a change in top-tier holding company with no change in charter. *HERF* is a bank-level Herfindahl index based on bank and thrift deposits (the only variable for which geographic location is publicly available). We first establish the Herfindahl index of the markets in which the bank has deposits and then weight these market indices by the proportion of the bank's deposits in each of these markets. *SHARE-ML* is the share of market bank and thrift deposits held by medium and large banks (*GTA* exceeding \$1 billion). *Ln(POP)* is the natural log of weighted average population in all markets in which a bank has deposits, using the proportion of deposits held by a bank in each market as weights. *Ln(DENSITY)* is the weighted average population density (natural log of population per square mile) in all markets in which a bank has deposits, using the proportion of deposits held by a bank in each market as weights. *INC-GROWTH* is the weighted average income growth in all markets in which a bank has deposits, using the proportion of deposits held by a bank in each market as weights. All regressions are run with both time fixed effects and bank fixed effects.

The sample period is 1993–2003. t-statistics based on robust standard errors clustered by bank are in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

the other exogenous variables. As shown, based on this alternative method to measuring liquidity creation, we obtain consistent results: the coefficient on *EQRAT* is positive for large banks, negative for small banks, and insignificant for medium banks.

In principle, this methodology could be applied to all bank activities. For example, the drawdown frequency is 1 for loans since customers have already received liquid funds. However, constructing measures using this methodology is difficult, since data on the frequency of drawdown or sale are unavailable for many activities. More importantly, the use of drawdown rates goes directly against the liquidity creation theories, which argue that banks create liquidity by giving customers the option to obtain liquid funds when needed or desired.

6.2 Using an alternative way of establishing which assets are securitizable

The amount of liquidity a bank creates is affected by the bank's ability to securitize its assets. Our "cat" liquidity creation measures incorporate this by classifying loan categories that are relatively easy to securitize (residential real estate loans and consumer loans) as semiliquid and all other loan categories as illiquid.[40] Our "cat" measures do not incorporate, however, the fact that the ability to securitize assets has developed greatly over our sample period. In every loan category, a larger fraction of loans was securitized in 2003 than in 1993. We now construct an alternative "cat fat" liquidity creation measure that takes this development into account.

Our alternative "cat fat" measure is identical to the "cat fat" measure described in Section 2, except for the way we classify loans. For each loan category, we obtain year-end U.S. Flow of Funds data on the total amount of loans outstanding and the total amount of loans securitized. We use these data to calculate the fraction of loans that has been securitized in the market in each year. Following Loutskina (2006), we then assume that each bank can securitize that fraction of its own loans. To give an example, in 1993, \$3.1 trillion in residential and real estate loans were outstanding in the market, and 48.4% of these loans were securitized. If a bank has \$10 million in residential and real estate loans in that year, we assume that 48.4% thereof can be securitized, and hence, we classify \$4.84 million of these loans as semiliquid and the remainder as illiquid.

We raise two reservations regarding this alternative approach for our purposes. First, it uses the actual amount of securitization, whereas the theories suggest that the ability to securitize matters for liquidity creation, not the amount securitized. Second, this alternative approach assumes that each bank securitizes the same fraction of loans in a particular category, even though in practice major differences may exist across banks. That is, when we assume that 48.4% of all residential and real estate loans can be securitized in 1993, one

[40] Our "mat" measures classify loans entirely based on maturities and hence do not take differences in securitizability into account.

bank may have securitized virtually its entire residential real estate portfolio in that year, while another bank may have securitized nothing.

Using this alternative approach, the banking sector created more liquidity, but the growth pattern is similar to the "cat fat" pattern described in Section 3. Based on this alternative measure, liquidity creation equaled \$1.843 trillion in 1993 and increased by about 70% to \$3.168 trillion in 2003.

The regression results presented in panel B of Table 7 reinforce our prior findings. That is, for large banks, the relationship between capital and liquidity creation is positive and significant. For small banks, the relationship between capital and liquidity creation is negative and significant. For medium banks, the relationship is again statistically insignificant.

6.3 Excluding equity from the measurement of liquidity creation

Our regression specification is inspired by the theories of bank liquidity creation. These theories argue that banks create liquidity when illiquid assets are transformed into liquid liabilities, not when they are transformed into illiquid claims such as equity. The theories also suggest that equity may affect a bank's ability to create liquidity. For example, having more equity capital may allow a bank to extend more illiquid loans. However, as noted in Section 5, a potential concern about our regression specification is that current bank equity is included (with a weight of $-½$) in our dependent variables, while the lagged equity ratio is our key exogenous variable. To ameliorate this potential concern, we create an alternative "cat fat" liquidity creation measure that excludes equity. This measure does not penalize banks for funding part of their activities with equity capital. As a result, the measured amount of liquidity creation is higher for all banks, and this increase is greatest for banks that hold the most capital. We rerun our regressions using this alternative measure.

The results shown in panel C of Table 7 suggest that our main findings are robust to the exclusion of equity from our dependent variable. The coefficient on *EQRAT* is again positive and significant for large banks, insignificant for medium banks, and negative and significant for small banks.

6.4 Using an alternative capital ratio

In our main analysis, we use *EQRAT*, the ratio of equity to *GTA*, as our key exogenous variable. We now replace *EQRAT* with *TOTRAT*, the ratio of total capital (as defined in the Basel I capital standards) to *GTA*. Total capital includes equity plus limited amounts of other financial instruments, such as long-term subordinated debt.[41,42]

[41] Before 1996, banks were not required to report total capital, and from 1996 to 2000, banks with total assets less than \$1 billion were not required to report total capital if they indicated on the Call Report that their total capital exceeded 8% of adjusted total assets. We estimate the missing numbers using a special Federal Reserve program based on other Call Report information.

[42] Note that we do not use the official Basel I total risk-based capital ratio, which is defined as total capital divided by risk-weighted assets, where risk-weighted assets is the weighted sum of assets and off-balance sheet activities, with the weights based on the perceived credit risk of each activity. This capital ratio is clearly endogenous and its use would result in significant bias, since our dependent variable, bank liquidity creation, is also a weighted sum of assets and off-balance sheet activities (as well as liabilities).

One motivation for using this alternative capital ratio is to see if there is a different effect of regulatory capital from conventional equity capital on liquidity creation. A second motivation is to allow for a broader definition of capital in line with some of the theoretical studies. For example, Diamond and Rajan (2000, 2001) indicate that capital in their analysis may be interpreted as either equity or long-term debt, sources of funds that cannot run on the bank.

The results based on this alternative capital ratio are shown in Table 8 and are qualitatively similar to our main results. The relationship between capital and liquidity creation is positive and significant for large banks, statistically insignificant for medium banks, and negative and significant for small banks.

6.5 Splitting the sample by bank holding company status, wholesale versus retail orientation, and merger status

In all of the regression results presented thus far, we have split our sample only by size. In Section 3, however, we also split our sample by bank holding company status, wholesale versus retail orientation, and merger status, and showed that substantial time-series and cross-sectional variation exists among these banks in terms of their ability to create liquidity. We now test the robustness of our main results by rerunning our regressions by size class for MBHC

Table 8
The effect of capital on liquidity creation based on an alternative capital ratio

	Large banks cat fat/*GTA*	Medium banks cat fat/*GTA*	Small banks cat fat/*GTA*
TOTRAT	1.696	0.048	−0.343
	(4.48)***	(0.05)	(−9.16)***
EARNVOL	−0.136	0.024	−0.019
	(−3.15)***	(0.37)	(−4.87)***
CREDITRISK	0.506	0.582	0.465
	(7.43)***	(3.46)***	(59.19)***
ZSCORE	0.007	0.009	−0.003
	(1.38)	(1.76)*	(−6.95)***
Ln(GTA)	−0.008	0.040	−0.003
	(−0.69)	(0.67)	(−1.39)
D-MBHC	0.079	0.007	0.016
	(0.82)	(0.54)	(18.42)***
D-OBHC	0.045	0.000	0.000
	(0.46)	(0.00)	(0.00)
D-BANK-MERGE	0.006	−0.003	0.009
	(0.64)	(−0.53)	(7.62)***
D-DELTA-OWN	−0.012	0.018	−0.003
	(−0.62)	(0.54)	(−3.22)***
HERF	0.028	−0.259	0.031
	(0.17)	(−0.64)	(3.23)***
SHARE-ML	−0.007	−0.100	0.019
	(−0.20)	(−1.90)*	(6.26)***
Ln(POP)	0.081	0.014	0.006
	(2.84)***	(0.47)	(2.22)**

(*continued overleaf*)

Table 8
(Continued)

	Large banks cat fat/*GTA*	Medium banks cat fat/*GTA*	Small banks cat fat/*GTA*
Ln(DENSITY)	−0.087	−0.018	0.017
	(−2.95)***	(−0.42)	(3.78)***
INC-GROWTH	0.993	−0.320	0.078
	(2.67)***	(−1.36)	(5.30)***
Constant	−0.346	−0.272	0.062
	(−1.48)	(−0.34)	(2.34)**
Time fixed effects	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes
Observations	1804	2132	80,062
Adjusted R-squared	0.78	0.67	0.88

This table presents regression results using an alternative capital ratio (discussed in Section 7.4). The dependent variable is cat fat/*GTA*, the dollar amount of liquidity a bank has created (calculated using our preferred "cat fat" liquidity creation measure as defined in Table 1) normalized by *GTA*. *GTA* equals total assets plus the allowance for loan and lease losses and the allocated transfer risk reserve (a reserve for certain foreign loans). Results are shown for large banks (*GTA* exceeding $3 billion), medium banks (*GTA* $1 billion–$3 billion), and small banks (*GTA* up to $1 billion).

TOTRAT is the ratio of total capital (as defined in the Basel I capital standards) to *GTA*. *EARNVOL* is the standard deviation of the bank's quarterly return on assets measured over the previous twelve quarters, multiplied by 100. *CREDITRISK* is a credit risk measure, calculated as the bank's Basel I risk-weighted assets and off-balance sheet activities divided by *GTA*. This variable is orthogonalized to avoid multicollinearity. *ZSCORE* is the distance to default, measured as the bank's return on assets plus the equity capital/*GTA* ratio divided by the standard deviation of the return on assets. This variable is orthogonalized to avoid multicollinearity. *Ln(GTA)* is the log of *GTA*. *D-MBHC* and *D-OBHC* are dummy variables that equal 1 if the bank has been part of a multibank holding company or a one-bank holding company over the prior three years. *D-BANK-MERGE* is a dummy that equals 1 if the bank was involved in one or more mergers over the past three years, combining the charters of two or more banks. *D-DELTA-OWN* is a dummy that equals 1 if the bank was acquired in the last three years, indicated by a change in top-tier holding company with no change in charter. *HERF* is a bank-level Herfindahl index based on bank and thrift deposits (the only variable for which geographic location is publicly available). We first establish the Herfindahl index of the markets in which the bank has deposits and then weight these market indices by the proportion of the bank's deposits in each of these markets. *SHARE-ML* is the share of market bank and thrift deposits held by medium and large banks (*GTA* exceeding $1 billion). *Ln(POP)* is the natural log of weighted average population in all markets in which a bank has deposits, using the proportion of deposits held by a bank in each market as weights. *Ln(DENSITY)* is the weighted average population density (natural log of population per square mile) in all markets in which a bank has deposits, using the proportion of deposits held by a bank in each market as weights. *INC-GROWTH* is the weighted average income growth in all markets in which a bank has deposits, using the proportion of deposits held by a bank in each market as weights. All regressions are run with both time fixed effects and bank fixed effects.

The sample period is 1993–2003. t-statistics based on robust standard errors clustered by bank are in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

members, OBHC members, and independent banks; banks with wholesale and retail orientations; and banks with and without recent M&A activity.

The results are shown in Table 9. For large banks, the coefficient on *EQRAT* is positive and statistically significant (except for the small subsample of independent banks, which has only fifty-four observations). For medium banks, the coefficient on *EQRAT* is positive and significant for OBHC members, and not significant for any of the other subsamples. For small banks, the coefficient is negative in all cases, and significant in all but one case. Thus, our main findings are generally robust to splitting the data by bank holding company status, wholesale versus retail orientation, and merger status.

Table 9

The effect of capital on liquidity creation for banks in each size class split by bank holding company status, wholesale versus retail orientation, and merger status

	MBHC members	OBHC members	Independent banks	Wholesale banks	Retail banks	Recent M&A activity	No recent M&A activity
	cat fat/*GTA*	cat fat/*GTA*	cat fat/*GTA*	cat fat/*GTA*	cat fat/*GTA*	cat fat/*GTA*	cat fat/*GTA*
Panel A: Regression results for large banks							
EQRAT	1.314	3.924	−0.365	1.709	0.553	1.275	1.261
	(3.74)***	(2.01)*	(−0.39)	(3.74)***	(1.80)*	(2.35)**	(2.12)**
Observations	1717	33	54	1255	549	1152	652
Adjusted R-squared	0.80	1.00	0.96	0.87	0.78	0.82	0.90
Panel B: Regression results for medium banks							
EQRAT	0.762	0.853	0.316	0.216	−0.107	0.366	0.321
	(0.64)	(1.94)*	(0.42)	(0.26)	(−0.29)	(0.88)	(0.32)
Observations	1722	187	223	1246	886	920	1212
Adjusted R-squared	0.70	0.96	0.95	0.73	0.93	0.94	0.72
Panel C: Regression results for small banks							
EQRAT	−0.380	−0.196	−0.282	−0.370	−0.231	−0.340	−0.345
	(−2.85)***	(−3.10)***	(−4.49)***	(−6.16)***	(−3.50)***	(−1.51)	(−7.42)***
Observations	33,864	28,426	17,772	55,314	24,748	5392	74,670
Adjusted R-squared	0.88	0.91	0.93	0.90	0.90	0.93	0.90

This table presents regression results. The dependent variable is cat fat/*GTA*, the dollar amount of liquidity a bank has created (calculated using our preferred "cat fat" liquidity creation measure as defined in Table 1) normalized by *GTA*. *GTA* equals total assets plus the allowance for loan and lease losses and the allocated transfer risk reserve (a reserve for certain foreign loans).

The sample is split in three ways. First, by bank holding company status: multibank holding company (MBHC) member, one-bank holding company (OBHC) member, and independent bank. Second, by wholesale versus retail orientation: banks with below versus above average number of branches. Third, by merger status: banks that engaged in M&A activity during the previous three years versus banks that did not engage in M&A activity recently.

Panels A, B, and C contain the results for large banks (*GTA* exceeding \$3 billion), medium banks (*GTA* \$1 billion–\$3 billion), and small banks (*GTA* up to \$1 billion), respectively. All panels show only the coefficients on *EQRAT* (total equity capital as a proportion of *GTA*) in the interest of parsimony, although the regressions include all the exogenous variables from the full specification as defined in Table 4. All regressions are run with both time fixed effects and bank fixed effects.

The sample period is 1993–2003. t-statistics based on robust standard errors clustered by bank are in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

6.6 Using an instrumental variable approach

All the analyses presented so far suggest that, based on our preferred "cat fat" liquidity creation measure, the relationship between capital and liquidity is positive and significant for large banks, and negative and significant for small banks. We have been careful thus far to interpret our results merely as showing strong correlations consistent with the theories rather than as evidence of a causal relationship, even though our main analysis used three-year lagged average values of capital to mitigate potential endogeneity concerns.[43] We now address this endogeneity issue more directly. Specifically, we use an instrumental variable approach to examine whether our statistically significant results about the positive relationship between capital and liquidity creation for large banks and the negative relationship between capital and liquidity creation for small banks represent the causal effects of capital on liquidity creation for large and small banks.[44]

Since we have panel data and use time and bank fixed effects in all of the regressions presented so far, we should also use fixed effects in our instrumental variable regressions.[45] We can do so if the instruments show sufficient variation over time. Provided this is the case, in the first stage, we will regress our potentially endogenous variable, *EQRAT*, on an instrument and all of the control variables and time and bank fixed effects. In the second stage, we will regress liquidity creation (using our preferred "cat fat" measure) divided by *GTA* on the predicted value for *EQRAT* from the first stage and all the control variables and fixed effects.

An instrument must satisfy two requirements. First, to be valid, the instrument should be correlated with the amount of lagged capital (once the effects of the other exogenous variables have been netted out), but should not directly affect the amount of liquidity a bank creates. Second, as noted above, since we want to include bank fixed effects in the regressions, it is important that the instrument shows sufficient variation within a bank's observations over time. We select two instruments: the first one meets both requirements, while the second one meets only the first requirement. Regressions that include the

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[43] In an earlier version of the article, we also investigated whether omitted variables could drive our results. For example, increased corporate governance pressures over time may have forced management of small banks to more aggressively court deposits and create liquidity, causing the observed negative relationship between capital and liquidity creation for these banks. To address this, we tested whether the negative effect is stronger for small banks in the second half of the sample period and examined whether capital ratios of small banks decreased over time. The results of these analyses were inconsistent with the alternative corporate governance explanation of our results.

[44] An alternative way to establish causality would be to shock banks with more capital (e.g., by imposing higher capital requirements) and examine the effect on liquidity creation. This is not possible for us, however, since such exogenous shocks did not occur during our sample period.

[45] We explained in Section 4.2 why it is important to include time and bank fixed effects in the main regressions. Our use of fixed effects in OLS and IV regressions is in line with the recent literature (e.g., Rajan and Zingales 1998; Anderson and Reeb 2003; Desai, Foley, and Hines 2004; Berger et al. 2008; Klapper, Laeven, and Rajan 2006). Although many papers do not elaborate on the first-stage regressions, it is clear from Levitt (2002) and Faulkender and Petersen (2006) that they explicitly include fixed effects in this stage.

instrument that meets both requirements are therefore carried out following the approach highlighted above. After discussing our instruments, we explain our approach for regressions that use the other instrument.

Our first instrument is *EFF-TAX*, the state income tax rate a bank has to pay. Since interest on debt is tax deductible while dividend payments are not, banks that operate in states with higher income tax rates are expected to have lower equity ratios, keeping all else equal. Furthermore, there is no reason to believe that the state income tax rate directly affects liquidity creation. Similar to Ashcraft (2008), we use the effective income tax rate to be paid on $1 million in pretax income as our instrument.[46,47] If a bank operates in multiple states, we use the bank's weighted average state income tax rate, calculated using the share of deposits in each state (relative to the bank's total deposits) as weights.[48]

Our second instrument is *SENIORS*, the fraction of seniors (people aged sixty-five and over) in the markets in which a bank is active. Seniors own larger equity portfolios than the average family. According to the Survey of Consumer Finances, families headed by a senior were slightly less likely to own stock (36.1% owned stock versus 47.5% of all families), but the dollar value of the stock portfolio of those that did own stock was roughly three times as large ($81,200 versus $27,000 for the average family) (see Bucks, Kennickell, and Moore 2006).[49] Furthermore, using U.S. data, Coval and Moskowitz (1999) document that investors have a strong preference for investing close to home. They find that this preference is greater for firms that are smaller, more highly levered, and those that produce goods that are not traded internationally. In combination, this evidence suggests that banks—particularly small banks—that operate in markets with more seniors have easier access to equity financing and hence, will use more equity financing. We calculate the fraction of seniors using county- and MSA-level population data from the 2000 decennial Census.[50]

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[46] In each state (except Ohio), the highest tax bracket starts at or below $1 million in pretax profits: when we use the marginal tax rate on $1 million in pretax profits as our instrument, we obtain similar results. In Ohio, banks pay 0.015 times the book value of their stock. However, for comparability reasons, we use the corporate income tax rate to calculate Ohio taxes.

[47] In contrast to Ashcraft (2008), we use the income tax rate banks have to pay rather than the corporate income tax rate. These rates differ in ten states. To illustrate, in South Dakota, corporations did not pay income tax between 1993 and 2003, while banks paid 6%. In North Dakota, corporations paid 10.35%, while banks were taxed at 7%. Also, unlike Ashcraft (2008), we do not average the tax rate over our sample period. This ensures that we do not use forward-looking data in our regressions.

[48] It would be preferable to use the share of pretax income earned in each state as weights, but Call Reports (and other data sources) do not provide these data.

[49] These calculations are based on data from the triennial Survey of Consumer Finances in 1995, 1998, 2001, and 2004, as presented in Tables 3 and 6 in Bucks, Kennickell, and Moore (2006). In particular, we compare average values for families headed by a senior (65–74-year-olds and 75-year-olds and above) with values for an average family.

[50] Becker (2007) uses Survey of Consumer Finances data to show that seniors also hold more deposits than the average family, and hence uses the fraction of seniors as an instrument for deposits of small banks. However, the impact of age on deposits is dwarfed by the impact of age on equity holdings. For example, in 2001, the median value of transaction accounts plus CDs for families headed by seniors was $13,400 (65–74-year-olds) and $15,900 (75-year-olds and up) versus $6000 for all families. In contrast, the median value of stock held by

Panel A of Table 10 examines the extent to which the instruments vary. The data suggest that there is substantial time-series variation for the tax rate for both size classes. We therefore use the entire sample and include time and bank fixed effects in all the analyses in which we employ the effective tax rate. The fraction of seniors shows sufficient variation in the cross section, but not over time since we only have information on the fraction of seniors from the 2000 Census. In the analyses that use *SENIORS*, we therefore do not use the entire sample and do not include time and bank fixed effects. Rather, we use liquidity creation data only from the year 2001 and lagged values of the instrument (i.e., the 2000 Census values) and the other exogenous variables.

Panel B of Table 10 shows the results of our first-stage regressions. The state income tax rate has a significantly negative effect on capital for large banks, consistent with Ashcraft (2008). The tax rate does not significantly affect capital at small banks, potentially because the tax benefit of debt may be outweighed by safety and soundness considerations that induce those banks to hold higher capital ratios. The fraction of seniors has a significantly positive effect on capital for small banks. It does not significantly affect capital at large banks, possibly because these banks are not limited by geography in terms of their access to a variety of funding sources.

Panel C of Table 10 contains the second-stage instrumental variable regression results. For completeness, we show results for both size classes using both instruments. However, since the first-stage results showed that the tax rate can only be used as an instrument for large banks while the fraction of seniors can only be used as an instrument for small banks, we focus our attention on those two regressions. When we use instruments for capital, our results are consistent with our earlier findings. The effect of capital on liquidity creation is positive and statistically significant for large banks, and negative and significant for small banks.

For both large and small banks, the coefficients on *EQRAT* are larger when we use instruments, suggesting that the effect of capital on liquidity creation is several times the previously estimated effect. Using similar logic as in Levitt (1996), this suggests that in our main liquidity creation regressions, *EQRAT* is correlated with the residuals, inducing a bias toward zero in our coefficient estimates. When we use instruments for capital, we obtain consistent estimates.[51] However, since we had no *a priori* reason to believe that our *EQRAT*

families headed by seniors was $58,800 (65–74-year-olds) and $41,000 (75-year-olds and up) versus $17,900 for all families. Values are calculated as the likelihood of holding a particular asset times the median dollar value of the holdings of those that do own that asset. The underlying data are from the 2001 Survey of Consumer Finances as presented in Tables 5B and 6 in Aizcorbe, Kennickell, and Moore (2003).

[51] Levitt (1996) finds that the number of prisoners has a negative effect on crime that is five times larger when he uses instruments for the prison population. He argues that the coefficients in his original regressions are too low because the number of prisoners is negatively correlated with the residuals and that he obtains consistent estimates when he uses instruments.

Table 10
The effect of capital on liquidity creation based on instrumental variable regressions

Panel A: Summary statistics on the instruments

	Large banks	Small banks	Fraction of seniors	Large banks	Small banks
Same tax rate in all years	31%	62%	Minimum	0%	0%
Tax rate changes >10%	44%	23%	Average	12%	14%
Tax rate changes >20%	19%	13%	Maximum	23%	35%

Panel B: First-stage regression results

	Instrument: *EFF-TAX*		Instrument: *SENIORS* (2001 data only)	
	Large banks *EQRAT*	Small banks *EQRAT*	Large banks *EQRAT*	Small banks *EQRAT*
EFF-TAX	−0.003	0.000		
	(−2.48)**	(1.44)		
SENIORS			−0.024	0.060
			(−0.27)	(3.66)***
Observations	1752	79,228	143	6493

Panel C: Second-stage regression results

	Instrument: *EFF-TAX*		Instrument: *SENIORS* (2001 data only)	
	Large banks cat fat/*GTA*	Small banks cat fat/*GTA*	Large banks cat fat/*GTA*	Small banks cat fat/*GTA*
EQRAT (instrumented)	4.820	−9.604	9.804	−2.531
	(1.75)*	(−1.45)	(0.25)	(−3.08)**
Observations	1752	79,228	143	6493

This table contains results from our instrumental variable approach for large banks (*GTA* exceeding \$3 billion), and small banks (*GTA* up to \$1 billion). *GTA* equals total assets plus the allowance for loan and lease losses and the allocated transfer risk reserve (a reserve for certain foreign loans). Panel A shows summary statistics on the instruments. Panel B contains first-stage regression results. The dependent variable is *EQRAT*, total equity capital as a proportion of *GTA*. Panel C shows second-stage regression results. In these regressions, the dependent variable is cat fat/*GTA*, the dollar amount of liquidity a bank has created (calculated using our preferred "cat fat" liquidity creation measure as defined in Table 1) normalized by *GTA* and *EQRAT* is alternatively instrumented with *EFF-TAX* and *SENIORS*.

EFF-TAX is the effective state income tax rate a bank has to pay on \$1 million in pretax income (see Ashcraft 2006). All regressions that include *EFF-TAX* are run with both time fixed effects and bank fixed effects. *SENIORS* is the fraction of seniors in all markets in which a bank has deposits, using the proportion of deposits held by a bank in each market as weights. The fraction of seniors is calculated using county- and MSA-level population data from the 2000 decennial Census. All regressions that include *SENIORS* are run with liquidity creation data only from the year 2001 and lagged values of the instrument (i.e., the 2000 Census values) and the other exogenous variables; since these are cross-sectional rather than panel regressions, time fixed effects and bank fixed effects are not included.

Panel B shows only the coefficients on the instruments, and panel C shows only the coefficients on *EQRAT* (total equity capital as a proportion of *GTA*) in the interest of parsimony, although the regressions include all the exogenous variables from the full specification as defined in Table 4 (except that bank and time fixed effects are excluded when *SENIORS* are used as the instrument).

The sample period is 1993–2003. *t*-statistics based on robust standard errors clustered by bank are in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

coefficients were understated in our main regressions, we are hesitant to put too much weight on this explanation.[52]

7. Conclusion

According to banking theory, banks exist because they create liquidity and transform risk. Our understanding of the liquidity creation role is hampered by the absence of comprehensive liquidity creation measures. The first contribution of this article is the development of four bank liquidity creation measures. Our second contribution is that we use our measures to gain a deeper insight into banks' role as liquidity creators. We determine the magnitude of bank liquidity creation, its intertemporal patterns, its cross-sectional variation, characteristics of high and low liquidity creators, and examine the relationship between liquidity creation and bank value. Our third contribution is that we use our measures to study an issue of significant research and policy relevance—the effect of bank capital on liquidity creation—and thereby test the predictions of recent theories about the relationship between capital and liquidity creation.

Our calculations suggest that liquidity creation by the U.S. banking sector exceeded \$2.8 trillion as of 2003 based on our preferred liquidity creation measure, and nearly doubled in real terms between 1993 and 2003. Interestingly, banks create only about half of their liquidity on the balance sheet, highlighting the importance of off-balance sheet liquidity creation. Large banks (gross total assets exceeding \$3 billion) create 81% of the liquidity while comprising only 2% of all banks. Multibank holding company members, retail banks, and recently merged banks create most of the industry's overall liquidity and show the greatest growth in liquidity creation over time. Liquidity creation is also positively associated with bank value.

When we test the relationship between capital and liquidity creation, we find empirical support for both the theories which predict that higher capital may suppress liquidity creation and those which suggest that higher capital may enhance banks' ability to create more liquidity. Based on our preferred "cat fat" liquidity creation measure, the relationship between capital and liquidity creation is positive and significant for large banks, insignificant for medium banks, and negative and significant for small banks. We perform a variety of robustness checks and find consistent results.

Our finding that the relationship between bank capital and bank liquidity creation differs by bank size raises interesting policy issues. It is well known that regulators impose capital requirements on banks for safety and soundness reasons. Our findings suggest that while regulators may be able to make banks safer by imposing higher capital requirements, this benefit may have associated

[52] Because our liquidity creation measure includes current capital, we also rerun the instrumental variable regressions with our liquidity creation measure that excludes capital as a robustness check. While we lose statistical significance for large banks, the results are similar for small banks.

with it reduced liquidity creation by small banks, but enhanced liquidity creation by large banks.

Our liquidity creation measures may also be used to address a number of other interesting issues that are beyond the scope of this article, but may be pursued in future research. Does liquidity creation affect economic growth? How do monetary policy initiatives by central banks, changes in deposit insurance, and other policy innovations affect liquidity creation? How does liquidity creation differ across nations? How much liquidity do banks create compared to nonbank financial intermediaries? How much liquidity do banks create relative to financial markets, and what are the complementarities, if any, in liquidity creation between banks and capital markets? Addressing these questions holds the promise of substantially improving our understanding of the liquidity creation function of banks and how it affects the economy.

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