# The Determinants of Bank Liquidity Buffer

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# The Determinants of Bank Liquidity Buffer


## Abstract

This study investigates factors that determine of the size of the liquidity buffer in banks. In the spirit of recent papers on bank liquidity management, we examine the impact of bank loan-related operations, bank characteristics, macroeconomic fundamentals, and regulatory policy on the bank liquidity buffer. We focus on how securitization and loan-deposit operations are related to the size of the liquidity buffer, because these activities have recently become manipulated by banks in order to minimize the influence of regulatory agencies on bank liquidity management. The results of this study suggest that all factors have a significant influence on the level of bank liquidity buffer, with the signs as expected. Securitization and loan-deposit synergy decrease the incentive for the bank to hold liquid assets on the balance sheet as a buffer. Monetary policy has a negative impact on the level of excess liquidity. The demand for liquidity is countercyclical, and bank excess liquidity runs counter to the business cycle. The level of bank liquidity buffer increases during a period of crisis. We also find that the deposit-loan synergy has a greatest effect on the size of bank liquidity buffer in terms of the economic significance.



**Key words:** Bank liquidity management, Liquidity buffer, Monetary policy.

# The Determinants of Bank Liquidity Buffer

## 1. Introduction

"Shortage in liquidity will kill you instantly and excess liquidity will kill you over time" is a well-known industry saying which serves as a very real warning to commercial banks across the globe of the dangers of poor liquidity management [as posted in Ambit, SunGard's business banking by Richard Chapman, Director of product management (2012)]. In recent years, the world economy has experienced a number of financial crises. Often, at the center of these crises are issues of liquidity provision by the banking sector and financial markets. For example, when crises are likely to arrive, banks seem less willing to lend and hold more liquidity due to the low level of liquidity in the market for external finance (Acharya, Shin, and Yorulmazer, 2011). Berger and Bouwman (2009b) found the connection between financial crises and bank liquidity creation: the subprime lending crisis was preceded by a dramatic build-up of positive abnormal liquidity creation, which implies that "too much" liquidity creation may also lead to financial fragility. Acharya and Naqvi (2010) are also successful in explaining how the seeds of a crisis may be sown when banks are flush with liquidity. Hence, bank liquidity management is important for both bank managers and policymakers in safeguarding overall financial stability.

There are two central issues in bank liquidity: liquidity creation and liquidity risk. Banks create liquidity to help their customers (depositors and companies) stay liquid, especially customers for whom other forms of financing are difficult to obtain. To reduce liquidity risk, banks retain their own liquidity to maintain their functions. Regulators generally force banks to maintain liquidity to prevent market crashes stemming from shortages of liquidity. This is the reason why banks hold a minimum amount of cash and liquid assets as a required buffer to ensure their obligations can be met if there is a freeze in funding markets. This required buffer is different from the bank's excess buffer. The excess buffer is considered to be the holding of liquid assets in excess of requirements. This helps banks ensure that the liquidity demands of their customers can be met in times of increased liquidity pressure. In fact, it is easy for banks to lose their liquidity because depositors can withdraw their funds or companies can exercise their loan commitments to borrow money when needed. When both actions occur at the same time, the bank could be unable to generate adequate cash

without incurring substantial financial losses, creating a run on the bank if serious. Obviously, managing liquidity risk forces banks to construct liquidity buffers which include both the required reserve and their excess reserve. The more liquid assets banks hold, the less liquidity risk they face. Nevertheless, few studies to date have analyzed the excess reserve phenomenon. How much liquidity do banks hold as self-insurance against liquidity shocks? How might the size of bank liquidity buffers be affected by bank idiosyncratic factors and by macro factors?

In this paper, we examine a set of factors found to affect the bank liquidity buffer in recent papers, including securitization (Loutskina, 2011), deposit – loan synergy (Gatev, Schermann and Strahan, 2006, 2007; Kashyap and Stein, 2002), bank characteristics (Aspach, Nier and Tiesset, 2005; Kashyap and Stein 1997; Kashyap, Rajan, and Stein, 2002; Loutskina, 2011), macroeconomic fundamentals (Acharya, Shin, and Yorulmazer, 2011; Aspach, Nier, and Tiesset, 2005; Berger and Bouwman, 2009; Gatev, Schermann and Strahan, 2006, 2007), and bank liquidity regulatory (Kashyap and Stein, 2000). Although studies have found that some factors crucial in determining the level of bank liquidity, those studies usually explore this issue by focusing on particular dimension affecting the bank liquidity. Our study, instead, aim to systematically investigate those important factors contributing to the bank liquidity buffer and examine which factor plays the most important role in determining the size of bank liquidity. Especially we incorporate the bank-specific factors such as the level of securitization, loan commitments, transaction deposits, and the synergy effect between loan and deposits in the consideration of bank liquidity buffer.

We propose four hypotheses in this study. First, securitization can create a new source of liquidity that banks need to offset the liquidity risk from depositors and borrowers, enabling them to reduce their liquid asset holdings to increase their lending ability. Therefore, it is predicted that securitization will negatively affect the size of the bank liquidity buffer. Second, the combination of loan commitments and transaction deposits can reduce the liquidity risk stemming from issuing loan commitments and lines of credit. This benefit can reduce the incentives of the bank to hoard liquid assets as a precautionary measure. We then predict that banks with a high level of deposit-loan synergy will have a smaller liquidity buffer. Third, the implementation of monetary policy enables banks to reduce their liquid excess reserve,

in turn reducing the level of liquid assets. Therefore, it is predicted that the existence of monetary policy results in a decrease in the size of the bank liquidity buffer. Finally, since the markets are imperfect, the demand for liquidity should be countercyclical, as banks would hoard liquid assets during recessions and offload them in good times when they have more opportunities to lend. Therefore, we predict that the business cycle and the size of the bank liquidity buffer will be negatively related and that the size of the bank liquidity buffer will increase during crisis periods.

Following the literature, we collect all bank-level data in a quarterly database using the Consolidated Report of Condition and Income (known as the "Call report") between 1997:I and 2010:IV to examine the hypotheses. For the data on the macroeconomic fundamentals and the worldwide bank loan portfolio, we directly access the Federal Reserve Board of Governors Release and the Federal Reserve Statistics Release "Flow of Funds Accounts of the United States". We choose the period of 14 years (1997 to 2010) to ensure the reliability of time series data and the study of bank liquidity buffers during crisis periods. At least four financial crises occurred during the sample period, including the Asian Financial Crisis (1997-1998), the Russia Debt Crisis/ Long-term Capital Management (LTCM) bailout (1998), the bursting of the dot.com bubble and the Sep. 11 terrorist attack (2000-2002), and the Global Financial Crisis (2007-2011). Our interest is the liquidity buffer ($B_{it}$) which is measured as marketable securities and federal funds sold as the share of total assets. Note that cash is not included in $B_{it}$ because it is likely to indicate the required reserve and hence is not easy to draw down. The independent variables are the determinants of the bank liquidity buffer, including the loan portfolio liquidity proxy for securitization of bank loans, loan commitments, transaction deposits, the loan-deposit combination proxy for the loan-deposit synergies, Fed funds, the paper-bill proxy for monetary policy, the GDP growth proxy for the business cycle, a crisis dummy variable, and bank-level control variables. To investigate the effect of determinants, we run an OLS regression on each factor and on all of them on the liquidity measure, and include additional control variables and time dummies for each quarter to account for changes in regulation, business cycle effects, and other trends. We also account for the size effect and use another measurement of bank liquidity buffer as a robustness test in the determining the bank liquidity buffer.

In the univariate tests, we examine the change in the level of the excess liquidity buffer within four quartiles of each idiosyncratic factor assigned the role of the sole factor affecting the excess liquidity reserve. The preliminary results reveal that bank idiosyncratic factors have a significant effect on the size of the bank liquidity buffer. We found that banks with a high level of securitization, deposit-loan synergy, and total assets (bank size) will hoard fewer liquid assets. Banks with a high level of transaction deposits will hold more liquid assets. However, there is a negative relationship instead of the expected positive relationship between the level of loan commitments and the size of the excess liquidity buffer. We conjectured that the liquidity risk may increase when either the level of loan commitments or the level of transaction deposits increases, resulting in an increase in the holding of excess assets. The results show a positive correlation between liquidity risk and transaction deposits, but not between liquidity risk and loan commitments. The results reveal a significant negative correlation between loan commitments and liquid assets. This negative correlation could be the result of substantial heterogeneity across banks in the costs of external financing.

The empirical results provide additional critical implications. In a multivariate analysis, each factor is examined on its own for its effect on the bank liquidity buffer and then all factors are considered together to examine how they affect each other and how they together affect the excess liquidity buffer. All results are statistically significant and most are consistent with our expectations. It is found that securitization, deposit-loan synergy, monetary policy (paper-bill), business cycle (GDP growth), and bank size are negatively correlated with the size of the excess liquidity buffer. The positive relationship between transaction deposit and liquidity buffer holds whether it is considered the sole factor or is combined with loan commitments. The correlation between loan commitments and the bank liquidity buffer is negative if it is considered as a sole factor in a regression but positive if it is combined with transaction deposits in the same regression. The level of excess liquidity buffer significantly increases during a crisis. The required risk-based capital following the Basel Accord's (total equity capital ratio) reduces the size of bank liquidity buffer, but it does not increase when the level of internal sources of funds (net income) rises. I find a negative relationship between monetary policy and the bank liquidity buffer when using paper-bill as a proxy but this relationship turns into

positive when the proxy is Fed funds rates. If Fed funds rates captures the stance of monetary policy well because it is sensitive to shocks to the supply of bank reserves (Bernanke and Blinder, 1992), the increases in paper-bill index can capture Fed tightening, since banks will cut loans and corporations are forced to substitute commercial paper for bank loans (Bernanke, 1990). Since our hypothesis is that a tightening of monetary policy decreases the size of the bank liquidity buffer, paper-bill appears to be a better proxy for monetary policy in this case, as shown by the results. In terms of the economic significance, the deposit-loan synergy has a greatest effect on the size of bank liquidity buffer, the following is monetary policy, business cycle, and the last one is securitization.

The remainder of this paper is organized as follows. Section 2 reviews the literature. Section 3 describes the hypothesis. Section 4 then presents the data, methodology and the empirical tests. Section 5 provides the empirical results. Section 6 concludes the paper.

## 2. Literature review

### 2.1. Bank liquidity buffer and bank loan-related operations

In this section, we summarize the main findings and methodology of papers which suggest the possible connection between bank loan-related operations and the bank liquidity buffer. We highlight the relationship between the bank liquidity buffer and bank managerial mechanisms, including deposit-loan synergy and securitization. These two mechanisms are both related to bank loan operations. When banks can use loan commitments and transaction deposits simultaneously, they can reduce the liquidity risk without the support of other sources of liquidity. This deposit–loan synergy therefore reduces the bank's incentives to reserve an amount of excess liquidity assets as a precaution. When banks can easily convert illiquid loans into liquid assets, they do not need to hold a large amount of liquid assets to meet unexpected liquidity demands from depositors. This securitization mechanism therefore also reduces the level of liquid asset holdings. In short, these findings show that there is a negative relationship between the bank liquidity buffer and bank loan-related operations.

Kashyap, Rajan and Stein (2002) address whether there is a real synergy between deposit-taking and lending in commercial banks. The authors suggest that since banks

often lend via commitments by which borrowers can take out loans on demand over some specified period of time, a mechanism which behaves like a demand deposit by which depositors can withdraw funds at any time. Thus, demand deposits and loan commitments represent the provision of liquidity on demand to capture unpredictable liquidity needs. Indeed, there may be a significant synergy between deposit-taking and lending. Furthermore, they argue that both loan commitments and demand deposits require banks to hold a certain overhead, which is the expense of maintaining the provision of liquidity on demand. The overhead includes a large amount of cash and securities that banks hoard as a buffer against unexpected liquidity shocks. Since the capital market is imperfect, banks cannot raise new external finance whenever they need it, meaning that the overhead is an expense that banks must incur whenever they have established a loan commitment or demand deposit. This overhead should thus have the potential for the synergy in which two activities can share some of the same costly overhead, enabling banks to offer both loan commitments and deposits to reduce the total amount of liquid-asset holdings to less than the amount of liquid assets in two separate institutions that operate only one of these functions. However, this synergy exists if and only if deposit withdrawals and commitment takedowns are not too highly correlated. Banks can use the buffer stock of deposit withdrawals to accommodate commitment takedowns in case there are no deposit outflows. These two arguments of Kashyap, Rajan and Stein (2002) suggest two empirical implications. First, across types of financial institutions, commercial banks should produce more commitment-basing loans than other intermediaries as well as taking on more long-term lending to borrowers, primarily through loan–commitments. Second, within the commercial banking sector, banks with the most pronounced advantage in offering demandable deposits (a high ratio of transaction deposits to total deposits) will hold more in cash and securities as well as have a higher level of loan commitments.

To demonstrate the theory, Kashyap, Rajan and Stein (2002) construct a simple model that captures the characteristics of a bank, including its role as a provider of demandable funds and costly expenses for unexpected raising of external funds. In this model, banks must maintain a buffer of liquid assets, a costly overhead. The authors note that their model does not predict an unconditionally positive correlation between commitments and liquid assets. It only indicates the correlation between

commitments and that component of liquid-asset holdings which is driven by demand deposits. In another word, banks with high levels of demand deposits will hold more liquid assets but may make fewer commitments, resulting in a negative correlation in an OLS regression of demand deposits with two variables, liquid assets and loan commitments.

Across different types of financial institutions, the evidence suggests deposit-taking banks offer relatively more commitments than other lending intermediaries. Kashyap, Rajan and Stein (2002) also found that banks are the principle source of funding for the unexpected credit needs of small firms. Within the banking sector, the evidence shows that an increase in demand deposits should lead to an increase in liquid-asset holdings. They also found a very strong positive correlation between commitment intensity and transaction deposit intensity. In addition, they found that commitments are positively related specifically to those liquid assets which are retained transaction deposits. However, whether this relationship is unconditionally positive is not predicted. They investigate a significant negative correlation between loan commitments and liquid assets in the data, saying that this negative correlation could be the result of substantial heterogeneity across banks in the costs of external financing.

Gatev, Schermann and Strahan (2006, 2007) examine the interaction between deposits and loan commitments relating to the liquidity risks. They argue that transaction deposits can ease the liquidity risk from unused loan commitments. Since the demand for liquidity from borrowers is not highly correlated with those from depositors, banks can use the inflows from transaction deposits to offset the liquidity demand increases of borrowers, enabling them to maintain their cash holding levels and enjoy a risk reduction. Therefore, when unused loan commitments rise, banks with a high level of transaction deposits will not experience a risk increase, whereas banks with a low level of transactions deposits will experience a risk increase. This risk reduction is a diversification benefit of liquidity risk management on both the asset side (loan commitments) and liability side (transaction deposits). Gatev, Schermann and Strahan (2006, 2007) term this the "deposit–lending risk management synergy". They investigate this hypothesis using the model presented by Kashyan, Rajan, and Stein (2002). The basic idea of the KRS model is that liquidity risks stemming from the two main businesses of

banking (lending and borrowing) produce a diversification synergy by combining transaction deposits with loan commitments. For data, the authors use the 100 largest publicly traded domestic banks. They focus on large banks to make sure their samples are more actively engaged with banking activities. The empirical results support this deposit-loan risk management synergy.

Gatev, Schermann and Strahan (2006, 2007) showed that this combined benefit becomes more powerful during market declines. In this period, banks face an increase in the demand for cash resulting from many customers withdrawing funds. However, at the same time investors tend to move funds from markets into banks because banks are safer thanks to the government safety net. Thus, transaction deposits increase and offset outflows. They investigate this hypothesis by separating data into two regimes based on the paper–bill spread indicating two market conditions: normal and tight liquidity. They argue that when spreads increase (when market liquidity becomes scarce), borrowers withdraw funds at the same time that inflows into bank transaction deposit accounts increase. Since the increased loan commitments have a higher risk for banks with a low level of transaction deposits, but a lower risk for banks with a high level of transaction deposits, as the spread rises, the deposit–lending synergy becomes stronger and stronger. Their empirical results show that there is a positive relationship between loan commitments and risk, and a greater combined benefit associated with transaction deposits during the market pullback.

Loutskina (2011) emphasized the important role of securitization in bank management, including management of bank liquidity and of funding. She investigated how securitization changes the way that individual banks manage their funding and liquidity as well as how these changes affect the traditional links between bank liquidity, cost of funds, and loan supply. She argued that securitization helped to transfer illiquid loans into marketable securities through the financial market, meaning that securitization provides a new source of liquidity assets. Thus, there is no need for banks to hold more liquid assets to serve unexpected demand from deposits and borrowers. Moreover, the liquid funds and loans are two components of bank assets. Therefore when the holding of liquid assets falls, the bank's lending ability will increase. Furthermore, the increasing

liquidity of loans makes the bank more willing to supply credit from the external funds instead of internal sources of funds (e.g., deposits).

To test these hypotheses, Loutskina (2011) constructed a new bank–specific index of bank loan portfolio liquidity which captures banks' ability to sell loans. This index is a weighted average of the potential to securitize loans of a given type (based on market-wide averages), in which the weights reflect the composition of an individual bank's loan portfolio and the growth in depth of the securitization market over time. She conducted a univariate analysis using this new loan liquidity index and found that there is a substitute effect between banks' ability to securitize loans and banks' holding of liquid assets, and that securitization increases the supply of bank loans. Furthermore, she followed the regression framework of Kashyap and Stein (2000) to investigate the links between bank liquidity, cost of funds, and the loan supply under the effect of securitization and argued that this regression allows her to take advantage of both time series and cross-sectional variation in the loan liquidity index and its interaction with the cost of external funds. Her empirical results show that securitization made loan growth (especially business loans) less sensitive to cost of funds shocks. This means that under the identical conditions of monetary tightening, banks with more liquid loan portfolios will have a smaller on-balance sheet decrease in lending than banks with a less liquid loan portfolio.

### 2.2. Bank liquidity buffer, macroeconomic fundamentals, and regulatory policy

In this section, we summarize several papers examining the effect of aggregate factors such as macroeconomic fundamentals and regulatory policy, on bank liquidity. These papers also present a significant effect of bank-specific characteristics on bank liquidity, including bank size, internal funds, and capitalization, which could be used as the bank-level control variables in the study. Bank size is emphasized in bank liquidity analysis by these papers, suggesting that further study of size effects is needed.

Berger and Bouwman (2009a) provide an overall understanding of bank liquidity creation by constructing new measures of liquidity creation. To construct these measures of liquidity creation, the authors classify all activities other than

loans based on their category (”cat”) and maturity (“mat”) while loans are solely classified by either “cat” or “mat” due to data limitations. They also include off-balance sheet activities (“fat”) and exclude them (“nonfat”) to examine how much liquidity banks create on the balance sheet versus off the balance sheet. They then combine all classified activities using their respective weights to construct four measures: “cat fat”, “mat fat”, “cat nonfat”, and “mat nonfat”. “Cat fat” is the condition in which loans are classified by category instead of maturity and the off-balance sheet activities are included to construct this measure. “Mat fat” is the condition in which loans are classified by maturity instead of category and the off-balance sheet activities are included. “Cat nonfat” is the condition in which loans are classified by category instead of maturity and the off-balance sheet activities are excluded. Finally, “mat nonfat” is the condition in which loans are classified by maturity instead of category and the off-balance sheet activities are excluded. The preferred measure is “cat fat” because for liquidity creation, a bank’s ability to securitize or sell loans is more important than loan maturity. Further, banks create liquidity both on and off the balance sheet. Based on these measures, Berger and Bouwman (2009a) offer a number of insights into liquidity creation, including the amount of liquidity banks create, the changes in liquidity creation over time, the variety of liquidity creation in cross section, the types of liquidity created most and least often, and the relationship between liquidity creation and bank value. In particular, their empirical results show that bank liquidity creation increases over time. There exists a positive relationship between liquidity creation and bank size, bank value, banks that are members of a multibank holding company, and banks engaged in M&A activity during the prior three years.

Furthermore, Berger and Bouwman (2009a) examine the effect of bank capital on bank liquidity creation using two hypotheses suggested in recent theorizing. First, they explore financial fragility-crowding out, which predicts a negative effect of bank capital on liquidity creation in which higher levels of capital reduce liquidity creation. According to Diamond and Rajan (2000, 2001), the additional capital makes a bank’s capital structure less fragile, making banks less amenable to monitoring, which increases their banks’ ability to create liquidity. Gorton and Winton (2000) also explain how bank capital reduces liquidity creation through the crowding out of deposits. Second, Berger and Bouwman (2009a) investigate the

risk absorption hypothesis which predicts a positive effect of bank capital on liquidity creation, meaning that higher levels of capital allow banks to create more liquidity. This theory contends that bank capital can absorb and expand banks' risk-bearing capacity. Their empirical results suggest that the financial fragility-crowding out hypothesis is relatively strong for small banks whereas the risk absorption hypothesis is relatively stronger for large banks. For medium-sized banks, these opposing effects cancel each other out.

Following the financial fragility-crowding out hypothesis, the negative effect on liquidity creation when capital increases is associated with the bank's deposits and capital monitoring when there is no decline in the value of loans. Such monitoring is typical for small banks where the capital market is single and less segmented. More bank equity capital would thus imply lower levels of bank deposits. Further, because small banks run in a single and less segmented market, a depositor can be an investor in bank equity and vice versa. In that case, any increase in bank capital is more likely to crowd out deposits. By contrast, large banks run in large and segmented capital markets such as national or international capital markets, meaning that an increase in bank capital may be caused by other equities rather than inducing a shift out of bank deposits. Large banks also use other liabilities that are less liquid than deposits. For large banks, an increase in capital may lead to a decline in other liabilities rather than deposits. Consequently, the financial fragility-crowding out hypothesis is weak for large banks. However, large banks often have greater requirements for regulatory control and market discipline than small banks, meaning that they need more capital to strengthen their capacity to absorb risk. This is the reason why the "risk absorption" hypothesis is consistent for large banks rather than small banks.

Berger and Bouwman (2009b) investigate the connection between bank liquidity creation and financial crises. They argue that there is an interaction between liquidity creation and financial crises: the creation of liquidity makes banks fragile and sensitive to runs and such runs can lead to crises via contagion effects. Meanwhile financial crises will interrupt the creation of liquidity when they occur. They first examine the behavior of bank liquidity creation around financial crises to bring to light the connections between aggregate liquidity creation and the financial crises. They also determine whether these connections vary with the

nature of crisis: bank crises resulting from the bank's inability to meet the liquidity demand and market–related crises resulting from the overvaluation institutions or assets in the market. To perform the analysis, the authors construct a measure of aggregate liquidity creation, the "cat fat", where "cat" indicates that loans are classified by category instead of maturity (all other activities are classified by both "cat" and "mat") and "fat" indicates that off-balance sheet activities included ( versus "nonfat"–exclude off-balance sheet activities). In term of liquidity creation, banks' ability to securitize or sell loans is important and banks create liquidity both on and off the balance sheet. Therefore, the "cat fat" measure can accurately reflect the level of bank liquidity creation. The process of constructing the liquidity creation measure follows Berger and Bouwman's 3-step procedure (Berger and Bouwman, 2009a). The empirical results are noteworthy: 1) There appears to be a significant build up or drop off in "abnormal" liquidity creation before each crisis. 2) There are differences between bank crises and market related crises: a particular bank crisis is predicted by an abnormal positive liquidity creation, whereas market-related crises are predicted by an abnormal negative liquidity creation. 3) Bank liquidity creation can increase and decrease during crises, implying that bank liquidity creation may exacerbate and ameliorate the effect of the crisis. 4) Off balance sheet guarantees moved more than on balance sheet assets during banking crises. 5) Too much liquidity creation may lead to financial fragility.

Second, Berger and Bouwman (2009b) analyze the effect of crises on the competitive position and profitability of banks based on their pre-crisis capital ratios. They argue that banks with high capital levels have a stronger ability to survive the crisis. The competitive implications of capital will be most obvious during a crisis. In testing this hypothesis, the authors separate the sample into two groups: large banks and small banks, based on the variation across bank size of the effect of capital on liquidity. The empirical results show that high capital-served banks are better off, especially around banking crises, while high capital ratios help small banks around banking crises, market-related crises, and normal times alike.

Berger, Bouwman, Kick and Schaeck (2010) investigate the effects of regulatory intervention and capital injections on liquidity creation and risk taking of distressed banks. They argue that applying regulatory interventions such as prohibiting the origination of new loans, imposing moratoria, revoking the charter,

and/or capital injections will help banks reduce risk during the period of distress, ensuring that the bank remains a going concern. However, at the same time, these measures affect to banks' ability to create liquidity. In particular, regulatory interventions will limit the banks' scope for business-related action. Thus, there is a reduction in liquidity creation. Berger, Bouwman, Kick and Schaeck (2010) label this the Regulatory Discipline Hypothesis. Additionally, capital injections may reduce liquidity creation because of the tradeoff between liquid liabilities and illiquid capital when capital increases, a phenomenon Berger, Bouwman, Kick and Schaeck (2010) term the Capital Injection Financial Fragility-Crowding out Hypothesis. However, capital injections may increase liquidity creation because they increase the banks' ability to absorb risk when capital is added. This they call the Capital injection Risk Absorption Hypothesis. Finally, both regulatory interventions and capital injections help banks reduce risk taking. They call the risk reduction resulting from the combination of these interventions the Risk Hypothesis.

They use a dataset of German universal banks which contains comprehensive information about supervisor and bank association discipline of distressed institutions and is broadly representative of other countries that have similar bank-based financial systems, including the U.S. To test their hypothesis, they use two types of models: an ordered logit model and partial proportional odds model, which helps avoid the potential drawbacks of OLS regressions. Empirical results support their hypotheses that (1) regulatory intervention and capital injections are associated with a decrease in liquidity creation and (2) risk taking falls after these measures. Furthermore, the banks' liquidity creation market shares decline over the 5 years following these disciplinary measures and banks also become safer during this period with the fall in risk taking. Yet, these effects are weakly reveal during periods of financial crisis.

Acharya, Shin and Yorulmazer (2011) study the effect of financial crises and their resolution on banks' choice of liquidity. They explore how banks choose their liquidity level in the upturns and downturns of the economy and how regulatory interventions to resolve banking crises affect the liquidity choices of banks.

During crises, there is an increase in disposing of risky assets which belong to failed banks at fire-sale prices. Since those risky asset prices may fall below their

basic value, surviving banks that purchase them could make a profit, especially if they can acquire the failed banks at a low cost. These gains encourage banks to hold more liquidity assets, not merely to survive the crisis at hand, but also to take advantage of the low price of potentially profitable assets. To examine this hypothesis, they consider that banks' portfolio choices to maximize their profit in the presence of fire sales are endogenously derived in an equilibrium setup of the banking industry. They found that there is a trade-off between holding liquid assets and investing in risky assets. In economic upturns, the expected profit on risky assets is high, as is the pledgeability of risky cash flow. As a result, risk exposure preferences drive banks to hold less liquid. Conversely, during economic downturns, the pledgeability of a risky cash flow is low but the opportunities for acquisition of low priced assets are high. Banks may then retain high levels of liquidity to underwrite future gains during the crisis. Thus, bank liquidity behavior runs counter to the business cycle, which fluctuates with the demand for risky loans. Furthermore, they also found that banks in the countries where there is an inefficient capital market and a poor legal and regulatory environment that impedes banks' ability to raise liquidity against future profits, banks tend to hold more liquidity assets. Thus, the greater the ease with which external finance may be obtained, the lower the level of liquid assets held by banks.

To aid the bank industry after crises, regulators can choose among a range of resolution policies such as bank bailouts and asset acquisitions for failed banks, or support of liquidity for surviving banks either unconditionally or conditioned on the amount of liquidity that a surviving bank has. These interventions also affect ex ante bank liquidity. In particular, policies such as bank bailouts, asset acquisitions by regulators, and provision of liquidity for surviving banks unconditionally enhance the fire-sale assets and reduce the incentives for banks to hold liquid assets. However, providing liquidity for surviving banks conditioned on the liquidity of banks enhances fire-sale assets but increases the incentives for banks to hold liquid assets.

## 3. Hypothesis

### 3.1. The bank liquidity buffer and bank loan-related operations

*3.1.1. Securitization and bank liquidity buffer*

Securitization, converting illiquid assets into liquid securities, has grown tremendously in recent years. The benefits of this financial innovation, such as improving risk sharing and reducing banks' cost of capital, are widely cited (e.g., Pennacchi, 1988). Securitization is changing the model of banking from one of 'originate and hold' to one of 'originate and sell', thereby mitigating the effects of both deposit supply and balance sheet liquidity on loan supply. Given that, Loutskina and Strahan (2009) show that a bank's willingness to approve jumbo mortgages (an example of illiquid loans) depends on both its cost of deposits and its holdings of liquid assets. More recently, Loutskina (2011) emphasized the important role of securitization as an essential part of bank liquidity-risk management. Banks carry their own liquid assets to meet unexpected liquidity needs from depositors and borrowers. If a bank can securitize existing loans as easily as it can convert liquid assets into cash, it is unlikely to hold liquid assets. Since securitization can create a new source of liquidity by converting illiquid loans into marketable securities, banks can reduce their level of liquid asset holding and increase their lending ability. Based on above arguments, I hypothesize:

**Hypothesis 1: Securitization is negatively correlated to the size of the bank liquidity reserve.**

*3.1.2. Deposit-Loan synergies and bank liquidity buffer*

Demand deposit accounts and the amount of undrawn credit lines are major factors in a bank's liquidity risk. Demand deposit accounts give banks a larger cash base and thus are a form of liquidity. Undrawn credit lines are a liquidity risk that is off the balance sheet. Companies with established credit lines can borrow from banks when they need it and thus decrease a bank's liquidity. However, banks can combine deposits and commitment lending to offset risks as transaction deposits can help banks hedge liquidity risk from unused loan commitments (Gatev, Schermann, and Strahan, 2007). This combination is based on a risk-management motivation: the demand for liquidity from borrowers is not highly correlated with those from depositors, meaning that banks can use the inflows from transaction deposits to offset the liquidity demand increase of borrowers, enabling them to maintain cash and enjoy a risk reduction. Therefore, banks offering more transaction deposits tend also to make more loan commitments (Kashyap, Rajan,

and Stein, 2002). Gate and Strahan (2006) contend that this combination of transactions deposits and loan commitments is negatively correlated with the systematic liquidity risk exposure stemming from issuing loan commitments and lines of credit. Banks can choose this strategy of managing liquidity risk to avoid failing instead of holding more liquidity assets. Therefore, I hypothesize:

**Hypothesis 2: The deposit-loan synergy reduces the size of the bank liquidity reserve.**

## 3.2. Bank liquidity buffer, macroeconomic fundamentals, and regulatory policy

### *3.2.1. Monetary policy and bank liquidity buffer*

The Federal Reserve Bank (FRB), commonly known as "the Fed" is the central bank of American banks. Its actions are designed to influence the supply and demand of money, impacting liquidity risk and creation, and in turn impacting the bank liquidity buffer as a result. The Fed takes actions specifically to manipulate the Federal Funds rate by influencing the amount of money supply in the banking system. This subsequently affects other rates in the markets as well (Madura, 2007). The tightening of monetary policy by the FRB has significant effects on bank liquidity buffers. When the FRB tightens monetary policy by selling bonds in the open market (the Paper-bill spread becomes wide, the Fed rate increases), the availability of depositary institutions in the market is drained up, and thus banks face a decline in the amount of insured deposits which is the cheapest source of the loanable funds for banks (Holod and Peek, 2007). The increase in the marginal cost of raising deposit induces banks to reduce their lending or use other sources of funds to finance loans in the existence of restricted external cost. The buffer of liquid funds (Kashyap and Stein, 2000) and other external sources of capital (Campello, 2002; Ashcraft, 2006) can insulate banks from the effect of cost of fund shocks. If banks reserve an amount of liquid funds, they will exercise it to support for lending instead of raising costly deposits when facing the tightened monetary policy, the amount of excess liquid funds they hold therefore will decrease**.** I thus hypothesize:

**Hypothesis 3: When the FRB tightens their monetary policy, the increase of Fed rate and Paper-bill spread will come along with the decline of the size of bank liquidity buffer.**

*3.2.2. Macroeconomic fundamentals and bank liquidity buffer*

Following Acharya, Shin, and Yorulmazer (2011), bank liquidity runs counter to the business cycle. This means that bank liquidity is low in normal economic times but high in economic downturns, such as crises. The business cycle fluctuates together with the demand for risky loans. In economic upturns, the expected profit from risky assets is high, as is the pledgeability of risky cash flow, making banks hold fewer liquid assets. Conversely, during economic downturns, the pledgeability of risky cash flows is low but the opportunities to acquire assets at fire sale prices are high. Banks may then hold much liquidity for future gains in crises. Berger and Bouwman (2009b) examined the behavior of bank liquidity creation around financial crises and showed that there is an abnormally high build-up of liquidity creation by banks prior to and during the initial phase of the current crises. Berger and Bouwman refer to this as the "dark side" of liquidity. The idea states that banks may have created too much liquidity in the market, causing financial fragility. Such studies open up the possibility that the business cycle strongly determines bank liquidity holding. In addition, as argued in hypothesis 2, considering the balance between demand deposit accounts and the amount of undrawn credit lines will improve the bank's financial efficiency (Gatev, Schuermann and Strahan, 2007). When the economy is uncertain, investors tend to entrust their money to banks while companies come to banks for funding. At the same time, bank's holding of cash increases due to the increasing demand deposits and decreases due to the increased demand from credit lines. If these two opposing liquidity channels balance each other, banks will be unable to originate new loans. Thus, this is an incentive for banks to hold more liquidity so that they can act as a liquidity provider for companies who do not have credit lines or need additional funding during a period of financial crisis. Acharya, Shin and Yorulmazer (2011) show that banks with larger liquidity buffers can take over the business of other banks by buying their assets at low prices. They argue that under the pressure of large liquidity and the lack of liquidity in the market because of financial crises, it is easy

for banks to lose their liquidity and sell their assets at low prices. This represents a great opportunity for banks that hold more liquidity to buy the risky assets at low prices and acquire other banks. During the financial crisis, the internal lending market experiences a significant decrease. Banks can rely on other banks to meet short term financing shortcomings due to a lack of liquidity. The internal borrowing and lending rate is influenced by the demand and supply of excess funds among banks (Madura, 2007). In the current crisis few banks were looking to lend, due to their own liquidity pressure. When internal lending dries up during crises making liquidity pressure more serious, banks may hold more liquid assets as a result. I thus hypothesize:

**Hypothesis 4a: The business cycle is negatively related to bank liquidity holding.**

**Hypothesis 4b: Banks hold a larger liquidity reserve during crisis periods.**

## 4. Data and Methodology

In this section we provide a detailed description of the data and sample selection. Additionally, we introduce the research model used to test our hypotheses, including the univariate analysis and the multiple regression analysis.

### 4.1. Sample and data

A number of studies of the banking industry collect bank-level data on a quarterly basis, including Berger and Bouwman (2009), Gatev, Schermann, and Strahan (2008), Kashyap and Stein (2000) and Loutskina (2011). Several used data from the Consolidated Report of Condition and Income (known as the Call Reports) that insured banks submit to the Federal Reserve each quarter. Following previous papers, our bank-level data come from the most recent quarter of the Call Report. We collect a data set with the quarterly income statements and balance sheet information for all reporting banks over the period 1997:I to 2010:IV. The panel is unbalanced since some of the banks do not report over the whole period of time.

When analyzing the data set, we drop all the bank-quarters in which information on dependent variables, independent variables, and any measurements of the securitization ($S_{it}$) and Liquidity ($B_{it}$) such as total assets, total loans, and liquid funds, is missing. To the extent possible, we exclude all banks that engaged in a merger or acquisition (M&A) during the year of the deal itself (but not in other years) by using bank mergers data from the Federal Reserve National Information Center. For

example, we drop both JP.Morgan and Chase during the years prior to the merger (1999 in this case), and treat them as a single bank in the year after the merger (2000 in this case). It is important to eliminate both acquirers and targets around M&A announcements because banks often substantially alter their lending behavior following such events. To prevent the effect of outliers on the results, WE exclude all bank-quarters with asset growth over the last quarter in excess of 100% and those with total loan growth exceeding 100%. The final data set contains 468,721 bank-quarters.

Many empirical studies show that size matters when studying components of bank liquidity. For example, Kashyap, Raijan and Stein (2002) provide empirical evidence that the relationship between commitments and transactions deposits is different for banks of different size classes. Berger et al. (2005) argue that large and small banks have comparative advantages in managing 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. In addition, Berger and Bouwman (2009) show that a bank with a high level of capital have a better ability to survive the crisis. However, a small bank with high capital ratios will operate smoothly around banking crises, market-related crises, and normal times alike while this effect is found for a large bank. Berger and Bouwman (2009) found that the effect of bank capital on bank liquidity creation for large banks and for small banks is contradictory. If higher capital allows large banks to create more liquidity, higher capital reduces small banks' liquidity creation. Furthermore, Loutskina (2011) found a difference in the ability and the benefit of expanding securitization markets between two groups: large banks and small banks. Obviously, many factors affect the bank's liquidity reserve size across bank size. Thus, WE separate the sample into two groups: large banks and small banks. Bank size is measured as the log of the total assets. If the total assets are in the bottom 75% of the size distribution, a bank quarter is assigned to the small banks' group. If the total assets are in the top 5% of the size distribution, the bank quarter is assigned to the large banks' group. All variables that are used in this study are described in Table 1. A detailed description will be given in section 4.2.

[Insert Table 1 about here]

## 4.2. Description of the variables

*4.2.1. Bank liquidity measurement*

The variable of interest, bank liquidity ($B_{it}$) is measured following Kashyap and Stein (2000) as the sum of the marketable securities and the Federal funds sold in the total assets. Cash is not included in $B_{it}$ because it is likely to reflect the required reserves which are not our interest in this study.

*4.2.2. Explanatory variables*

Securitization is a new issue in banking sector. The measure of securitization ($S_{it}$) is computed following Loutskina (2011) as a weighted average of the potential to securitize loans of a given type (based on market-wide averages) in which the weights reflect the composition of an individual bank's loan portfolio. The proposed index is:

$$S_{it} = \sum_{j=1}^{6} \frac{\text{Securitized loans of type j at time t}}{\text{Total loan outstanding of type j at time t}} \times (\text{share of type j loans in bank i portfolio at time t})$$

To construct this index, six categories of loans are broken down from the bank loan portfolio: (1) home mortgages, (2) multi- family residential mortgages, (3) commercial mortgages, (4) consumer credit, (5) business loans not secured by real estate (commercial and industrial loans), and (6) farm mortgages. The degree of loan liquidity for the six loan categories is computed as the ratio of loans securitized to total loans outstanding. The index can be computed using market-level data from the US Flow of Funds and individual bank-level data on loans from the Report of Condition and Income. The amount of loans outstanding, loans securitized, and the degree of loan liquidity for the six loan categories over the sample period 1997: I to 2010: IV are reported in Table 2, which shows that home mortgages occupy a large proportion of outstanding loans as well as loans securitized in the loan portfolios of U.S. banks. It is thus clear why the crash of the home mortgage market is the primary cause of the recent global financial crisis. Consequently, the role of securitization, which is insufficiently discussed in the literature, should be a concern in bank liquidity management.

[Insert Table 2 about here]

In considering the effect of the combination of transactions deposits and loan commitments, $LoanCommitments_{i,t}$ is the ratio of unused loan commitments to commitments plus loans, and $DepositBase_{i,t}$ is the ratio of transaction deposits to total deposits.

*Monetary policy proxies* – To proxy the cost of external financing for banks, two different monetary policy indicators are used: the Federal funds rate (*Fed Funds)*; the difference between the rates paid on six-month prime-rated commercial papers and 180-day Treasury bills (*Paper-bill*). We use two proxies because the Fed funds rate captures the stance of monetary policy well since it is sensitive to shocks to the supply of bank reserves, whereas the Paper-bill index captures Fed tightening since banks will cut loans and corporations are forced to substitute commercial paper for bank loans. These indicators of monetary policy are constructed using time series data available from the Federal Reserve. All policy measures are transformed so that increases in their levels represent Fed tightening. They are also normalized to have the same standard deviation.

*GDP growth* is used to proxy for the business cycle. The banks' liquid asset holding behavior runs counter to the business cycle, lower during economic upturns and higher in recessions. In addition, banks tend to hold more liquidity assets during crisis periods than during normal economic times. Therefore, we use the dummies for each quarter to account for the recession period, *Crisis*. The economy is in crisis period if it equals 1, and zero otherwise.

For bank-level control, we include the following: bank size (the log of total assets), additional internal sources of funds in times of stress (the ratio of net income to total assets), and ability to raise funds externally (bank size). Controlling for size is particularly important because of its correlation with independent variables such as loan commitments and securitization. Furthermore, Basel Accord requires all bank reserve a minimum ratio of equity to risky asset which will influence the bank liquidity buffer, so we use the level of capitalization (the ratio of equity capital to total assets) to control the effect of this restriction. Blundell-Wignall and Atkinson (2010) argue that if banks are solvent, and have adequate capital, then the management of their liquidity and funding should in principle be responsible for them. König (2010) suggest the bank's overall failure risk by means of liquidity requirements can be

reduced if and only if these are implemented in conjunction with minimum capital requirements. Hováth et al. (2012) find that capital requirements negatively Granger-cause liquidity creation in the sample of small banks. This negative relationship has been found in Distinguin et al. (2012) in which the main results reveal a fewer amount of bank regulatory capital comes along with the increase of liquidity creation. Given that the previous papers reveal a certain interrelation between the adequate capital and bank liquidity; we suggest that the level of bank liquidity buffer ($B_{it}$) may be reduced by the required risk-based capital following to the Basel Accord's.

### 4.3 Summary statistics

Table 3 presents summary statistics of various research variables for the sample. There are two parts. Panel A reports the descriptive statistics for the full sample and for the subsamples of small and large banks. Panel B shows the Pearson correlation coefficients of these research variables. To examine the reliability of data, we compare and contrast the summary statistics of several key variables in this paper with studies that also use bank-level data coming from the Call Reports, including Loutskina (2011) and Gatev, Schuermann and Strahan (2006, 2007). The results suggest that most statistics are approximately similar to those in the literature. In Panel B, the initial signs of the relationship between the bank liquidity buffer and its determinants appear. Intuitively, with the negatively significant coefficients of $S_{it,}$ Size, Paper-bill, and GDP growth, a negative relationship between the bank liquidity buffer ($B_{it}$) and securitization, bank size, monetary policy, and the business cycle may be expected. The results also suggest that the alternative measure of liquidity ($AB_{it}$) is correlated with the principal factors more consistently with our predictions than the initial measure ($B_{it}$). In particular the evidence appears to show a positive correlation between the size of the bank liquidity buffer and loan commitments, transaction deposits, and total equity, as well as a negative relationship between the size of the liquidity buffer and securitization, monetary policy, the business cycle, and bank size. The correlation between $AB_{it}$ and deposit-loan synergy remains positive but not significant while $B_{it}$ is positively significant, correlated with deposit-loan synergy. Those are optimistic signs for the outcome of the follow-on analysis of our hypotheses.

[Insert Table 3 about here]

Panel A reports the descriptive statistics for the full sample and for the subsamples of small and large banks. Comparing small and large banks, we can see that the small banks tend to hold more liquid assets (32.42% versus 26.98% of total assets), and fewer loans (61.07% versus 64.59% of total assets). This is consistent with the difficulty small banks encounter in raising external financing, unlike larger banks. Smaller banks must maintain a larger liquidity buffer to protect themselves from cost of funds shocks. Small banks also have a higher level of unused loan commitments (107.12% versus 64.99%). This is consistent with small banks have more liquidity risk stemming from unused loan commitments and thus needing a larger liquidity buffer to protect against unexpected liquidity demand from borrowers. On the liability side, small banks are mostly financed by deposits (83.01% of total assets) and equity (15.16%), in contrast to large banks that have a smaller scale of both deposits and equity (70.45% and 10.3%, respectively). Small banks also have a higher level of transaction deposits than large banks (23.56% versus 9.31%). Hence, small banks also suffer a higher liquidity risk stemming from depositors than large banks, another reason why small banks tend to hold more liquid assets on their balance sheets. In the table, we see that the securitization of loan portfolios in small banks is lower than in large banks (22.9% versus 23.24%). This is consistent with small banks having more trouble obtaining funds by securitizing their loan portfolios and thus maintaining a larger liquidity buffer than large banks, which find it easier to securitize illiquid loans into liquid securities.

Panel B reports the Pearson correlation coefficients of these variables. Intuitively, with the negatively significant coefficients of $S_{it,}$ Size, Paper-bill, GDP growth, it appears likely that there will be a negative relationship between the size of the bank liquidity buffer ($B_{it}$) and securitization, bank size, monetary policy, and business cycle. These results also suggest that the alternative measure of liquidity ($AB_{it}$) is correlated with principal factors more consistently with our predictions than the initial measure ($B_{it}$). The evidence shows a positive correlation between the size of the bank liquidity buffer and loan commitments, transaction deposits, and total equity, as well as a negative relationship between the size of the liquidity buffer and securitization,

monetary policy, the business cycle, and bank size. The correlation between $AB_{it}$ and deposit-lending synergy remains positive but is not significant while $B_{it}$ is positively and significantly correlated with deposit-lending synergy.

## 5. Empirical results

### 5.1. Univariate Analyses

Initially, we perform the cross-sectional analysis of levels of bank liquidity ($B_{it}$), bank loan portfolio liquidity ($S_{it}$), Loan commitments, Transactions deposits, Deposit-Loan combination and bank size for various sub-periods of the sample. We classify the full sample 1997: I – 2010: IV into four sub-periods which we use to observe the changes of bank liquidity before, during, and after financial crises. Next, we use these subsamples to conduct a simple difference test. Firstly, we divide the sample of bank-quarters into four quartiles based on the distribution of the loan liquidity measure $S_{it}$ and compute the average bank liquidity $B_{it}$ for each quartile. We repeat the quartile-separating process for loan commitments, transaction deposits, and deposit-lending, and also compute the average bank liquidity $B_{it}$ for each quartile. Table 4 presents the result for the cross-sectional analysis of the size of the bank liquidity buffer based on bank loan portfolio liquidity ($S_{it}$), the unused loan commitments (LC), transaction deposits (TD), the deposit-lending synergies (LC*TD), and bank size. Panel A presents the average liquidity assets ($B_{it}$) for the four loan liquidity quartiles and the difference in liquid assets ($B_{it}$) between banks with more liquidity and banks with less loan liquidity. The results suggest that banks with lower loan liquidity have more liquid assets on their balance sheets than those with higher loan liquidity. The difference in the size of the bank liquidity buffer ($B_{it}$) between banks in the least liquid loan quartile and banks in the highest liquid loan quartile is significant at the 1% level for the full sample as well as its various subsamples. The negative relationship between the level of bank liquidity assets and securitization of the loan portfolio is consistent with our expectation. Obviously, banks that find it easier to convert illiquid loans into liquid assets hold fewer liquid assets. However, this negative relationship cannot be found for 2002: I and 2007: IV when the mean differences are negative, which indicate that the average size of the liquidity buffer in the low quartile is less than in the high quartile. These two periods represent the bursting of the dot.com bubble and the Sep.11 terrorist attack, which was the

beginning of the latest global financial crisis. The reasons why banks retained large liquidity buffers despite the high level of securitization of their loan portfolios are to protect against the rising liquidity risk and to hoard liquid assets in order to exploit opportunities during the crisis.

[Insert Table 4 about here]

Panel B of Table 4 presents the average liquidity assets ($B_{it}$) for the four loan commitment (LC) quartiles and the difference in liquid assets ($B_{it}$) between banks with high levels of loan commitments and banks with low levels of loan commitments. The results show that banks with lower levels of loan commitment have more liquid assets. The difference in bank liquidity measures between banks in the lowest and highest levels of loan commitments is significant at the 1% level of the full sample and its various sub-samples. Unfortunately, this negative relationship is not consistent with our prediction. As we mentioned above, the increase of unused loan commitments is accompanied by an increase in the liquidity risk that causes banks to hold more liquid assets, and vice versa.

Panel C presents the average liquidity assets ($B_{it}$) for the four transaction deposit (TD) quartiles and the difference in liquid assets ($B_{it}$) between banks with high levels of TD and bank with low levels of TD. These results suggest that banks with higher levels of transaction deposits have more liquid assets. The difference in bank liquidity measures between banks in the lowest and highest levels of TD is significant at the 1% level of the full sample and its various sub-samples. The positive relationship between the level of bank liquid assets and the level of transaction deposit is consistent with our prediction. To meet the increase of liquidity demand from depositors, banks may hold more liquid assets. This positive relationship holds across the four sub-periods of time as well.

Panel D presents the average liquidity assets ($B_{it}$) for the four deposit-lending combination (LC*TD) quartiles and the difference in liquid assets ($B_{it}$) between the combination of low levels of TD and LC and the combination of high levels of TD and LC. These results suggest that banks with high deposit-lending synergy have fewer liquid assets than banks with low deposit-lending synergy. The difference in bank liquidity measures between banks in the lowest and highest levels of

deposit-lending synergies is significant at the 1% level of the full sample and its various sub-samples. As predicted, the benefit of a combination of high deposits and high loans reduces the liquidity risk on both sides of the balance sheet, then there is no need for banks to hold many liquid assets. This mechanism provides banks with the ability to relax their holding of liquid assets for other strategies without concern for unexpected liquidity demand.

Panel E of Table 4 considers the relationship between bank size and the size of the bank liquidity buffer in the cross-sectional framework. It presents the average liquidity measures across size quartiles for the full sample of bank-quarters as well as for the various subsamples. We find that large banks tend to maintain smaller bank liquidity buffers than small banks. This negative relation between the size of the bank liquidity buffer and bank size is consistent with our prediction. Banks in the highest size quartile have around 6.84% less liquid funds in total assets compared with the lowest size quartile banks. The results are economically and statistically significant at the 1% level. The evidence is consistent with the argument that large banks are more efficient in managing their liquid funds and have greater ability to raise external finance.

### 5.2. Multivariate Analyses

We next conduct the regression analysis to evaluate the relationship between the bank liquidity buffer ($B_{it}$) and its idiosyncratic as well as aggregate determinants. At first, we test the effect of each factor on the level of bank liquidity measure including additional control variables. For the bank-specific factors, we additionally include time dummies for each quarter ($\eta_t$) to account for changes in the regulation, business cycle effects, and other trends. The estimated equations are:

$$H_1: B_{it} = \beta_0 + \beta_1 S_{it} + \text{other bank} - \text{level control variables}_{it} + \eta_t + \varepsilon_{it} \quad (1)$$

$$H_2: B_{it} = \alpha_0 + \alpha_1 LC_{it} + \alpha_2 TD_{it} + \alpha_3 (LC * TD)_{it} + \text{other bank} - \text{level control variables}_{it} + \eta_t + \varepsilon_{it} \quad (2)$$

$$H_3: B_{it} = \gamma_0 + \gamma_1 Fed_t + \gamma_2 Paperbill_t + \text{other bank} - \text{level control variables}_{it} + \varepsilon_{it} \quad (3)$$

$$H_4: B_{it} = \delta_0 + \delta_1 GDP_t + \delta_2 Crisis_t + \text{other bank} - \text{level control variables}_{it} + \varepsilon_{it} \quad (4)$$

In model (1), as securitization can create a new source of liquidity that substitutes for traditional liquid funds in banks' balance sheets, the coefficient of bank loan liquidity ($ß_1$) is expected to negative.

In model (2), since both unused loan commitments and transactions deposits have a risk of unexpected liquidity demands, an increasing level of each of these factors should be found in tandem with an increase in bank liquidity holdings. Thus, the coefficients of these factors ($\alpha_1$, $\alpha_2$) are expected to positive. However, the combination of these factors produces a diversification effect that decreases the liquidity risk and therefore reduces bank liquidity holdings. The coefficient of interception ($\alpha_3$) should thus be negative. To examine this hypothesis, we first run the regression of each variable as a sole factor affecting the size of the liquidity buffer and then run the regression of both factors as a compound affecting the size of the liquidity buffer. Under the deposit-lending synergy hypothesis, the correlation between loan commitments and transaction deposits is significant, meaning that a regression including both factors will produce more certain results for the size of the liquidity buffer than a regression for on either factor alone.

In model (3), the size of the bank liquidity reserve will decrease with a tightening of the monetary policy. Thus, the coefficient of this determinant ($\gamma_1$, $\gamma_2$) is expected to negative. We examine this hypothesis for each proxy (Fed, Paper-bill) and for both proxies at the same time to observe which is a better proxy for capturing the monetary policy effect.

In model (4), $Crisis_t$ is a dummy variable equal to one for every quarter after and including the occurrence of a financial crisis and zero otherwise. Since bank liquidity holdings runs counter to the business cycle, we expect that the coefficient of GDP ($\delta_1$) is positive if $Crisis_t = 1$ (recession) and negative if $Crisis_t = 0$ (normal or upturn). Further, banks tend to hold more liquid assets during the crisis to take advantage of opportunities to purchase other banks' assets at fire-sale prices. Thus, the coefficient of the dummy proxy for the financial crisis factor ($\delta_2$) is expected to be positive if $Crisis_t = 1$, and negative if $Crisis_t = 0$.

Finally, we put all idiosyncratic and aggregate factors into a regression examining the effect of all determinants of bank liquidity reserve at the same time to confirm whether these factors retain their own effect when combined with other factors which might the impact on the size of the bank liquidity buffer as well.

In this way we hope to identify which factor primarily determines the level of bank liquidity assets. The estimated equation is:

$$(5a)\quad B_{it} = \lambda_0 + \lambda_1 S_{it} + \lambda_2 LC_{it} + \lambda_3 TD_{it} + \lambda_4 (LC * TD)_{it} + \text{other bank} - \text{level control variables}_{it} + \eta_t + \varepsilon_{it}$$

$$(5b)\quad B_{it} = \pi_0 + \pi_1 S_{it} + \pi_2 LC_{it} + \pi_3 TD_{it} + \pi_4 (LC * TD)_{it} + \pi_5 Fed_t + \pi_6 Paperbill_t + \pi_7 GDP_t + \pi_8 Crisis_t + \text{other bank} - \text{level control variables}_{it} + \varepsilon_{it}$$

Table 5 presents the results of the OLS analysis with the independent bank-specific variables for full sample. The results are all statistically significant. We find that the bank liquidity buffer is negatively correlated with the securitization of loans. These results are similar for both the equation for H1, which considers the effect of only securitization of the loan portfolio ($S_{it}$) and equation (5), which considers the effect of all factors on the size of the bank liquidity buffer. The evidence suggests that, when securitization of the bank loan portfolio increases by 1%, the size of the bank liquidity buffer maintained by a bank decreases on average around 1.12% when only the effect of securitization is tested, and around 1.54% if the effects of all other factors are combined. In terms of the economic significance, increasing the securitizability of loan portfolios by one standard deviation decreases the level of bank liquidity buffer by approximately 0.11% in regression (1) and 0.16% in regression (5b). Given that the mean liquidity buffer equals 23%, this effect represents a decline of 0.49% and 0.7% on the relative basic, respectively. This finding provides consistent support for hypothesis 1.

[Insert Table 5 about here]

Only the factor transaction deposit has results consistent with our predictions in both (2b) considering the effect of only the level of transaction deposit (TD) and (5) considering the effect of all factors on the size of the bank liquidity buffer. Meanwhile, loan commitments are not consistent if it is treated as a sole factor. However, when we let two factors affect the size of the bank liquidity buffer at the same time, the prediction of hypothesis 2 is confirmed in (2c) and (5). This evidence suggests that, when the level of the transaction deposits or loan commitments increases by 1%, the size of the liquidity buffer increases on average around 24.01% and 4.86% in

regression (2c), respectively; and 24.73% and 4.1% in regression (5b), respectively. This positive relationship indicates that when there is an increase in the liquidity risk as the level of transaction deposit or loan commitments increases, banks should hold a larger liquidity buffer. However, when the deposit-loan combination increases 1%, the size of the bank liquidity buffer will decrease on average around 39.15% in regression (2c) and 38.51% in regression (5b). This is a significant drop due to the diversification benefit stemming from the combination. In terms of the economic significance, increasing the deposit-loan synergy by one standard deviation decreases the level of bank liquidity buffer by approximately 1.62% in regression (2c) and 1.6% in regression (5b). Given that the mean liquidity buffer equals 23%, this effect represents a decline of 7.04% and 6.96% on the relative basic, respectively. This finding provides consistent support for hypothesis 2. This synergy has the largest effect on the size of the bank liquidity buffer in term of the economic significance. Obviously, the deposit-lending adjustment mechanism is the most important determinant.

For the effect of monetary policy on the size of the bank liquidity buffer, the results are consistent with the variable Paper-bill but not with Fed. The evidence suggests that, when the FRB tightens monetary policy by increasing the Paper-bill index by 1%, the size of the liquidity buffer will decrease on average around 1.4% in regression (3b). This effect is consistent around 4.16% in regression (5b) when combined with all other factors. In terms of the economic significance, increasing the Paper-bill index by one standard deviation decreases the level of bank liquidity buffer by approximately 1.59% in regression (5b). Given that the mean liquidity buffer equals 23%, this effect represents a decline of 6.91% on the relative basic. This finding provides consistent support for hypothesis 3. Meanwhile, an increase in Fed funds rate leads to an increase in the size of the bank liquidity buffer. These results suggest that the Paper-bill index captures Fed tightening better than the Fed funds rate.

The business cycle has the greatest impact on the size of the bank liquidity buffer. The sign is consistent with our expectation. It is predicted that the business cycle runs counter to the size of the bank liquidity buffer. The evidence suggests that when GDP growth increases by 1%, the size of the bank liquidity buffer decreases on average around 546.2% in regression (5b). In terms of the economic significance, increasing

the GDP growth by one standard deviation decreases the level of bank liquidity buffer by approximately 1.09% in regression (5b). Given that the mean liquidity buffer equals 23%, this effect represents a decline of 4.75% on the relative basic. This finding provides consistent support for hypothesis 4a. This negative relationship decreases during the period of crisis but remains significant. This indicates the important effect of the variable "Crisis" in considering the determinants of the size of the bank liquidity buffer. In fact, the size of the bank liquidity buffer increases on average around 1.78% during a crisis (regression 4c) and around 1.43% in regression (5b) when considering the effects of other variables. This finding provides consistent support for hypothesis 4b.

The coefficients of bank size and total equity capital are consistent with our predictions, while those of net income are not. This indicates that banks that can easily raise additional external funds (large banks) will maintain a smaller bank liquidity buffer; the minimum amount of equity to risky assets required by government negatively affect to the incentives of banks to hold liquid assets on balance sheet. The negative correlation of bank liquidity buffer with net income is significant but very weak (0.003%). It appears that this factor may have only a negligible effect on the size of the bank excess liquidity reserve.

Finally, except for net income, the remaining variables have a significant effect on the size of the bank liquidity buffer with the signs as expected. These variables retain their own effect even in combination with other factors. Among bank-specific factors, the deposit-lending synergy is the most powerful determinant while the business cycle determines the size of the bank liquidity buffer when the factors are aggregated. The bank size effect is significant and consistent across all regressions.

### 5.4. Robustness test

*5.4.1. Do the liquidity reserve effects differ by bank size?*

In the previous regression, we controlled for bank size by including the log of total assets as a regressor. However, it is known that banks of different size classes have fundamentally different balance sheet compositions (Berger et al., 2005) and that this affects the amount of liquidity created by these banks (Berger and Brouwman, 2009). Research also shows that monetary policy has different effects on liquidity creation by bank size class (Berger and Bouwman, 2009, 2010). Furthermore, bank

size can reflect the ability of banks to raise external financing. Acharya, Shin, and Yorulmazer (2011) found that the greater the difficulty banks face in raising external financing, the more liquid assets they will hold. Consequently, we separate the full sample into two subsamples: small banks and large banks, and we run all regressions for these two subsamples to consider whether the strength of the relationship between these factors and bank liquidity reserve changes with bank size.

[Insert Table 6 about here]

Table 6 presents the results of the OLS analysis with independent bank-specific variables for two subsamples: small banks and large banks. The results of the variables in both sub-samples including securitization ($S_{it}$), deposit-lending synergy (LC*TD), monetary policy (Paper-bill), business cycle (GDP growth), crisis periods (Crisis), bank size, and total equity capital are significant and consistent with results in Table 5. This evidence suggests that the effects of the variables remain across bank size, except for loan commitments. However, for large banks, net income has a significantly positive effect on the size of the bank liquidity buffer (around 27.57% on average). In addition, the positive relationship between loan commitments and the size of the bank liquidity buffer does not hold for all loan commitment-related regressions, but the results are not significant. For small banks, this positive relationship remains except for regression (5b) in which all factors are combined, though the results are also not significant. Generally, all results in Panel A of Table 6 mimic the results in Table 5 while there are some differences between Panel B of Table 6 and Table 5. This means that all factors that contribute to the whole sample also affect small banks. The effect of all principal factors remains across bank size.

*5.4.2. Do the liquidity reserve effects differ when using another measure of liquidity?*

The measure of liquidity that we used in the previous regression is described in Kashyap and Stein (2000) as liquid assets as a share of the bank's total assets. This measure is interesting since it is based on the split between liquid and illiquid assets (such as loans) on the bank's balance sheet. However, arguably, it does not capture well the degree of liquidity mismatch inherent in the bank's balance sheet. To analyze

this, we construct an alternative liquidity ratio, the ratio of liquid assets to total deposits. We will run all regressions for this alternative dependent variable.

[Insert Table 7 about here]

Table 7 presents the results of the ordinary least squares (OLS) regression analysis for full sample and two subsamples, in which the dependent variable is the size of the liquidity buffer ($AB_{it}$), defined as the ratio of liquid assets to total deposits. The results suggest that the effect of principle liquidity variables including securitization, deposit-loan synergy, monetary policy, the business cycle, and crisis periods, remains. However, the relationship between bank-level characteristics and the excess liquidity buffer changes. By this measure, the negative correlation between bank size and bank liquidity holds only for small banks. This relationship reverses significantly for the whole sample. The negative correlation between total equity capital and bank liquidity buffer is not captured by this measure, the coefficients are positively significant for large banks and the whole sample, and only insignificant for small banks. However, this measure can generate a positive relationship between the internal source of funds (net income) and the size of the bank liquidity buffer even though these results are significant only for large banks. Generally, all results for large banks imitate those for the whole sample. It seems that this alternative measure captures the effect of bank-specific factors within large banks while the initial measure captures the effect of bank-specific factors within small banks.

In sum, despite using different measures of the size of the bank liquidity buffer or considering effects across banks of different sizes, the effect of principle liquidity determinants including securitization, deposit-loan synergy, monetary policy, the business cycle, and crisis periods on the size of the bank excess liquidity buffer remains significant.

## 6. Conclusions and Discussions

In this study, we attempt to investigate the impact of bank-specific factors and aggregate factors on the size of the bank liquidity buffer. Several studies have investigated bank liquidity and liquidity creation and connected bank liquidity with

bank-specific and macroeconomic factors. Those researchers have successfully constructed a measure of bank liquidity as well as generated many interesting findings related to bank liquidity. These studies motivated us to construct the hypotheses about the determinants of the size of the bank liquidity buffer, an area in which research remains scant. We collected a set of variables that are related to bank liquidity and bank liquidity risk including bank-idiosyncratic variables such as securitization, and deposit-lending synergy, and bank-specific factors such as bank size, net income, and total equity capital, and macroeconomic factors such as monetary policy, the business cycle, and crisis periods. We use them to run a regression with the size of the bank liquidity buffer to examine of the effects of these factors on the bank liquidity buffer. We also examine the consistency of these effects across bank size and by using an alternative measure of liquidity.

We found that: (1) Securitization of the loan portfolio can reduce the incentives for the bank to hold liquid assets as a precaution. (2) Banks can manage loan commitments and transaction deposits simultaneously to reduce the liquidity risk stemming from the transaction deposit. This mechanism is the deposit-lending synergy which generates a benefit from the diversification between loan commitments and transaction deposits. This benefit can reduce the incentives for banks to hoard liquid assets against increases in the liquidity risk. (3) When the FRB tightens monetary policy, banks have to exercise their liquidity reserve and the size of the liquidity buffer therefore decreases. (4) Banks tend to hoard liquid assets during economic downturns while holding fewer liquid assets during the normal and upturn periods. (5) The size of the liquidity buffer increases significantly during crisis periods. (6) Bank size significantly and positively affects the size of the bank liquidity buffer. Further, the measure of liquidity as a share of total assets can capture the effects of the principle determinants well for small banks while the alternative measure of liquidity as a ratio of total deposits captures the effects better for large banks. Most empirical results are statistically significant and consistent with our expectations. In terms of the economic significance, the deposit-loan synergy has a greatest effect on the size of bank liquidity buffer, the following is monetary policy, business cycle, and the last one is securitization.

Since previous studies suggest relationships between bank liquidity and either bank-specific characteristics or aggregate factors, we combined them and examined

them for their effects on the size of the bank excess liquidity buffer. Further, we investigated the connection between the size of the bank liquidity buffer and two bank-related managerial mechanisms: securitization and deposit-lending synergy, which are increasingly developed in modern banking. The significant relationship between them and the size of the bank liquidity buffer sheds new light on bank liquidity management. For banking, liquidity risk is as important as liquidity creation, and a bank liquidity buffer is key a requirement of liquidity management. A better understanding of the determinants of the size of the bank liquidity buffer will enable banks and regulators to manage liquidity more efficiently. However, the determinants we examine in this study are the first step of the issue. We have not examined other important issues surrounding bank liquidity buffers, including how the cost of holding a liquidity buffer affects the size of the liquidity buffer. Further, to have a whole picture of bank liquidity, it's essential to link bank liquidity with bank performance: Do the determinants of bank liquidity buffer affect to bank performance? Do banks will have out-performance when they successfully manage their liquidity?. Those are the important questions remaining for future studies.

**References**

Acharya, V., Naqvi, H., 2010. The seeds of a crisis: A Theory of Bank Liquidity and Risk - Taking over the Business Cycle. Journal of Financial Economics 106, 349-366.

Acharya, V., Shin, H., Yorulmazer, T., 2011. Crisis Resolution and Bank Liquidity. The Review of Financial Studies 24(6), 2166-2205.

Ashcraft, A., 2006. New evidence on the lending channel. Journal of Money, Credit, and Banking 38 (3), 751–776.

Aspachs, O., Nier, E., Tiesset, M., 2005. Liquidity, Banking Regulation and the macroeconomy: Evidence on bank liquidity holdings from a panel of UK-resident banks. Mimeo, London School of Economics.

Berger, A. , Bouwman, C., Kick, T., Schaeck, K., 2010. Bank liquidity creation and risk taking during distress. Deutsche Bundesbank Discussion Paper Series 2: Banking and Financial Studies No 05.

Berger, A., Bouwman, C., 2009a. Bank Liquidity Creation. The Review of Financial Studies 22(9), 3779-3837.

Berger, A., Bouwman, C., 2009b. Financial Crises and Bank Liquidity Creation. Working Paper, 08-37, Wharton Financial Institutions Center.

Berger, A., Rosen, R., Udell, G., 2005. Does Market Size Structure Affect Competition? The Case of Small Business Lending. CEI Working Paper Series 2005-8, Center for Economic Institutions, Institute of Economic Research, Hitotsubashi University.

Bernanke, B., 1990. On the predictive power of interest rates and interest rate spreads. New England Economic Review, Federal Reserve Bank of Boston, 51-68.

Bernanke, B., Blinder, A. , 1992. The Federal Funds Rate and the Channels of Monetary Transmission. American Economic Review, American Economic Association 82(4), 901-921.

Blundell-Wignall, A., Atkinson, P., 2010. Thinking beyond Basel III: Necessary Solution for Capital and Liquidity. OECD Journal: Financial Market Trends 1, 1–23.

Campello, M., 2002. Internal capital markets in financial conglomerates: evidence from small bank responses to monetary policy. Journal of Finance 57, 2773–2805.

Diamond, D., Rajan, R., 2000. A Theory of Bank Capital. Journal of Finance, American Finance Association 55(6), 2431-2465.

Diamond, D., Rajan, R., 2001. Banks, short-term debt and financial crises: theory, policy implications and applications. Carnegie-Rochester Conference Series on Public Policy, Elsevier 54(1), 37-71.

Distinguin I., Roulet C., Tarazi A., 2013. Bank Regulatory Capital and Liquidity : Evidence from US and European publicly traded banks. Journal of Banking and Finance, 37, 3295-3317.

Gatev, E., Schuermann, T., Strahan, P., 2006. Managing bank liquidity risk: How deposit –loan synergies vary with market conditions. NBER Working Paper No. 12234.

Gatev, E., Schuermann, T., Strahan, P., 2007. How Do Banks Manage Liquidity Risk? Evidence from the Equity and Deposit Markets in the Fall of 1998. NBER Working Paper No. 10982.

Gatev, E., Schuermann, T., Strahan, P., 2009. Managing bank liquidity risk: How deposit –loan synergies vary with market conditions. The Review of Financial Studies 22, 995-1020.

Gorton, G., Winton, A., 2000. Liquidity Provision, the Cost of Bank Capital, and the Macroeconomy. Working Paper, University of Minnesota.

Holod, D., Peek, J., 2007. Asymetric information and liquidity constrains: A new test. Journal of Banking and Finance 31(8), 2425-2451.

Horváth, R., Seidler, J., Weill, L., 2012. Working Paper Series No.1497.

Kashyap, A., Stein, J., 1997. The impact of monetary policy on banks' balance sheets. Carnegie-Rochester Conference Series on Public Policy 42, 151–195.

Kashyap, A., Stein, J., 2000. What do a million observations on banks say about the transmission of monetary policy? American Economic Review 90, 407–428.

Kashyap, A., Stein, J., 2002. Banks as liquidity providers: an explanation for the coexistence of lending and deposit-taking. Journal of Finance 57, 33–73.

König, P., 2010. Liquidity and Capital Requirements and the Probability of Bank Failure. SFB 649 Discussion Paper 2010 No.027.

Loutskina, E. , Strahan, P., 2009. Securitization and the Declining Impact of Bank Finance on Loan Supply: Evidence from Mortgage Acceptance Rates. NBER Working Paper No. 11983.

Loutskina, E., 2011. The role of securitization in bank liquidity and funding management. Journal of Financial Economics 100, 663–684.

Madura, J., 2007. Financial Markets and Institutions. Mason: South-Western/Cengage Learning.

Pennacchi, G., 1988. Loan Sales and the Cost of Bank Capital. Journal of Finance, American Finance Association 43(2), 375-96.

**Table 1: Dependent and explanatory variables in the econometric regression**

| Hypothesis | Determinants | Definitions | Expected Sign to Liquidity Buffer |
|---|---|---|---|
| $H_1$: Securitization | Loan portfolios liquidity ($S_{it}$) | A weighted average of the potential to securitize loans of a given type. $S_{it} = \sum_{j=1}^{6} \frac{\text{securitized loans of type j at time t}}{\text{total loan outstanding of type j at time t}}$ x (share of type j loans in bank i portfolio at time t) | negative |
| $H_2$: Deposit-Loan Synergies | Loan Commitments (LC) | LC = Unused loan commitments/ (unused loan commitments + Loans) | positive |
| | Transaction deposit (TD) | TD = Transaction deposits / Total deposits | positive |
| | LoanCommitments * Transactions Deposits (LC *TD) | A risk-managed strategy that reduce the banks' incentives to hold traditional liquid assets | negative |
| $H_3$: Monetary Policy | Fed funds (FED) | Monthly series of the effective annualized U.S. Federal funds rates provided by the Board of Governors Release | negative |
| | Paper-bill (Paperbill) | Paper-bill = the rates paid on 3-month prime rated commercial papers – 120-day Treasury bills ( available from the Board of Governors') | |
| $H_{4a}$: Business cycle | GDP growth | Quarterly growth of U.S. GDP, in constant prices | negative |
| $H_{4b}$: Financial Crisis | *Crisis:* Dummy variable | *Crisis* = 1 for every quarter after and including the financial crisis happening, and 0 for otherwise | positive |
| *Bank-level control variables* | | | |
| Ability to raise external funds | Size | Size = Log of total assets | negative |
| Additional internal sources of funds | Net income (NICOME) | Net income / Total assets | positive |
| The level of capitalization | Total equity capital (TEQUITY) | Total equity capital/ Total assets | negative |
| *Dependent variable* | | | |
| Liquidity buffer as a share of the balance sheet | Liquidity ratio ( $B_{it}$) | $B_{it}$ = (Fed funds sold and securities purchased under agreements to resell + securities held to maturity + available for sale securities) / Total Assets | |
| Liquidity buffer as a share of the balance sheet | Liquidity ratio ($AB_{it}$) | $AB_{it}$ = (Fed funds sold and securities purchased under agreements to resell + securities held to maturity + available for sale securities) / Total Deposits | |

## Table 2: The securitization of loan portfolio ($S_{it}$)

The table presents the aggregate, economy-wide amounts of the loans outstanding, loans securitized, and the loan liquidity index (securitization) for six loan categories over time period 1997: I-2010: IV. All the data are taken from the "Flow of Funds Accounts of the United States" and the Report of Condition and Income. Total mortgages represent the aggregate of home mortgages, multifamily residential mortgages, commercial mortgages, and farm mortgages. Total loans represent the aggregate of all six loan categories.

| Loan categories | 1997:I | | 2001:I | | 2004:I | | 2007:I | | 2010:IV | | 1997:I - 2010:IV |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Outstanding | Securitized | Outstanding | Securitized | Outstanding | Securitized | Outstanding | Securitized | Outstanding | Securitized | Average of Sit |
| Panel A: All figures in millions | | | | | | | | | | | |
| HOME MORTGAGES | 3,727,255 | 1,930,757 | 5,218,015 | 2,867,387 | 7,457,606 | 3,982,162 | 10,702,479 | 6,127,441 | 10,420,972 | 2,364,960 | 0.1529 |
| MULTIFAMILY RESIDENTIAL MORTGAGES | 274,451 | 49,433 | 392,241 | 116,634 | 542,132 | 172,309 | 695,611 | 196,869 | 810,140 | 165,642 | 0.0049 |
| COMMERCIAL MORTGAGES | 746,986 | 48,054 | 1,113,697 | 176,860 | 1,443,956 | 283,083 | 2,107,716 | 543,454 | 2,185,305 | 518,280 | 0.0385 |
| FARM MORTGAGES | 75,431 | 429 | 85,665 | 1,637 | 86,286 | 966 | 109,191 | 3,402 | 141,200 | 3,759 | 0.0011 |
| LOANS TO BUSINESS (C&I LOANS) | 1,811,255 | 34,290 | 2,393,043 | 109,600 | 2,180,650 | 150,435 | 2,925,466 | 275,580 | 2,905,302 | 167,808 | 0.0067 |
| CONSUMER CREDIT | 1,254,175 | 278,296 | 1,749,724 | 546,897 | 2,096,472 | 580,545 | 2,365,100 | 636,983 | 2,541,559 | 62,756 | 0.0290 |
| TOTAL MORTGAGES | 4,824,123 | 2,028,673 | 6,809,618 | 3,162,518 | 9,529,980 | 4,438,520 | 13,614,997 | 6,871,166 | 13,557,617 | 3,052,641 | 0.1974 |
| TOTAL LOANS | 7,889,552 | 2,341,259 | 10,952,385 | 3,819,015 | 13,807,102 | 5,169,500 | 18,905,563 | 7,783,729 | 19,004,478 | 3,283,205 | 0.2331 |
| Panel B: All figures in ratio of total loans | | | | | | | | | | | |
| HOME MORTGAGES | 0.47243 | 0.82467 | 0.47643 | 0.75082 | 0.54013 | 0.77032 | 0.56610 | 0.78721 | 0.54834 | 0.72032 | 0.65578 |
| MULTIFAMILY RESIDENTIAL MORTGAGES | 0.03479 | 0.02111 | 0.03581 | 0.03054 | 0.03926 | 0.03333 | 0.03679 | 0.02529 | 0.04263 | 0.05045 | 0.02108 |
| COMMERCIAL MORTGAGES | 0.09468 | 0.02052 | 0.10169 | 0.04631 | 0.10458 | 0.05476 | 0.11149 | 0.06982 | 0.11499 | 0.15786 | 0.16531 |
| FARM MORTGAGES | 0.00956 | 0.00018 | 0.00782 | 0.00043 | 0.00625 | 0.00019 | 0.00578 | 0.00044 | 0.00743 | 0.00114 | 0.00456 |
| LOANS TO BUSINESS (C&I LOANS) | 0.22958 | 0.01465 | 0.21850 | 0.02870 | 0.15794 | 0.02910 | 0.15474 | 0.03540 | 0.15287 | 0.05111 | 0.02881 |
| CONSUMER CREDIT | 0.15897 | 0.11887 | 0.15976 | 0.14320 | 0.15184 | 0.11230 | 0.12510 | 0.08184 | 0.13373 | 0.01911 | 0.12447 |
| TOTAL MORTGAGES | 0.61146 | 0.86649 | 0.62175 | 0.82810 | 0.69022 | 0.85860 | 0.72016 | 0.88276 | 0.71339 | 0.92977 | 0.84673 |
| TOTAL LOANS | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

## Table 3: Summary statistics of research variables, 1997: I – 2010: IV

The table contains two parts. Panel A presents the descriptive statistics of research variables (see definition in Table 1) in the full sample and in the sub-samples of large banks (top 5% in size) and small banks (bottom 75% in size). I exclude all bank-quarters with asset growth over the last quarter in excess of 100%, those with total loan growth exceeding 100%. Panel B presents Pearson correlation coefficients for these research variables in the full sample. The data are from the Federal Reserve's Report of Condition and Income, the Flow of Funds Accounts of the United States database, and the Board of Governors Release H.15 for the period from 1997:I to 2010:IV. **. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed)

Panel A: Descriptive statistics

| Variables | OBS | | | Mean | | | Std. Deviation | | | Minimum | | | Median | | | Maximum | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Full sample | Small banks | Large banks | Full sample | Small banks | Large banks | Full sample | Small banks | Large banks | Full sample | Small banks | Large banks | Full sample | Small banks | Large banks | Full sample | Small banks | Large banks |
| Total assets (millions) | 468,720 | 351,492 | 23,453 | 1,020,000 | 83,500 | 17,200,000 | 19,050,000 | 56,309 | 83,520,000 | 1 | 1 | 1,199,008 | 99,600 | 69,800 | 2,850,000 | 2,000,000,000 | 230,034 | 2,000,000,000 |
| Liquid funds 1 (ratio of total assets, $B_{it}$) | 468,720 | 351,492 | 23,453 | 0.3110 | 0.3242 | 0.2698 | 0.1646 | 0.1669 | 0.1585 | 0 | 0 | 0 | 0.2895 | 0.3052 | 0.2456 | 1 | 1 | 0.9994 |
| Liquid funds 2 (ratio of total deposit,$AB_{it}$) | 466,736 | 351,492 | 23,453 | 1.7068 | 0.6932 | 16.2786 | 251.4745 | 27.8760 | 1,094.5106 | 0 | 0 | 0 | 0.3479 | 0.3588 | 0.3407 | 165,140 | 13,321 | 165,140 |
| Total loans (ratio of total assets) | 468,720 | 351,492 | 23,453 | 0.6237 | 0.6107 | 0.6459 | 0.1687 | 0.1700 | 0.1753 | 0 | 0 | 0 | 0.6483 | 0.6338 | 0.6748 | 1.2073 | 1.2073 | 1.061 |
| Unused loan commitments (ratio of total assets) | 468,720 | 351,492 | 23,453 | 0.9101 | 1.0712 | 0.6499 | 38.7112 | 44.3378 | 3.6881 | 0 | 0 | 0 | 0.0834 | 0.0709 | 0.1810 | 11,283 | 11,283 | 101.0516 |
| Total deposits (ratio of total asset) | 468,720 | 351,492 | 23,453 | 0.8188 | 0.8301 | 0.7045 | 0.1224 | 0.1171 | 0.1805 | 0 | 0 | 0 | 0.8485 | 0.8570 | 0.7483 | 1.1519 | 1.1519 | 1.0082 |
| Transactions deposits (ratio of total assets) | 468,720 | 351,492 | 23,453 | 0.2129 | 0.2356 | 0.0931 | 0.1085 | 0.1033 | 0.0689 | 0 | 0 | 0 | 0.2102 | 0.2301 | 0.0800 | 1 | 1 | 0.6982 |
| Net income (ratio of total asset) | 468,720 | 351,492 | 23,453 | 0.0364 | 0.0462 | 0.0077 | 16.3483 | 18.8786 | 0.0124 | 0 | 0 | 0 | 0.0054 | 0.0053 | 0.0059 | 10,822 | 10,822 | 0.5504 |
| Total equity (ratio of total asset) | 468,720 | 351,492 | 23,453 | 0.1164 | 0.1516 | 0.1040 | 0.0871 | 0.1455 | 0.0608 | -5.19 | -5.19 | -0.0648 | 0.0973 | 0.1108 | 0.0903 | 1 | 1 | 0.958 |
| Loan Commitments (ratio, *LC*) | 468,714 | 351,492 | 23,453 | 0.1346 | 0.1188 | 0.2584 | 0.1071 | 0.0947 | 0.1846 | 0 | 0 | 0 | 0.1178 | 0.1040 | 0.2173 | 1 | 1 | 1 |
| Deposits_base (ratio, *TD*) | 468,717 | 351,492 | 23,453 | 0.2577 | 0.2817 | 0.1413 | 0.1311 | 0.1240 | 0.1292 | 0 | 0 | 0 | 0.2537 | 0.2746 | 0.1134 | 1 | 1 | 1 |
| Securitizability of loan (ratio, *Sit*) | 468,720 | 351,492 | 23,453 | 0.2300 | 0.2290 | 0.2324 | 0.1010 | 0.1007 | 0.1050 | 0 | 0 | 0 | 0.22 | 0.2209 | 0.2246 | 1 | 0.6239 | 0.628 |
| Size (Ln of total assets) | 468,720 | 351,492 | 23,453 | 11.6491 | 11.0594 | 15.2784 | 1.3665 | 0.8113 | 1.2319 | 0 | 0 | 13.9970 | 11.5093 | 11.1530 | 14.8643 | 21.2935 | 12.346 | 21.2935 |
| Fed funds(ratio) | 468,720 | 351,492 | 23,453 | 3.3591 | 3.4728 | 3.1082 | 2.1154 | 2.0974 | 2.1384 | 0.12 | 0.12 | 0.12 | 3.97 | 4.16 | 3.04 | 6.53 | 6.53 | 6.53 |
| Paper-bill (ratio) | 468,720 | 351,492 | 23,453 | 0.4424 | 0.4407 | 0.4503 | 0.3823 | 0.3707 | 0.4103 | 0.08 | 0.08 | 0.08 | 0.37 | 0.39 | 0.34 | 1.78 | 1.78 | 1.78 |
| GDP growth (ratio) | 468,720 | 351,492 | 23,453 | 0.01 | 0.01 | 0.01 | 0.002 | 0.002 | 0.003 | 0 | 0 | 0 | 0 | 0 | 0.01 | 0 | 0 | 0 |

Panel B: Pearson correlation coefficients

| | $B_{it}$ | $AB_{it}$ | LC | TD | $S_{it}$ | SIZE | Fed | Paperbill | GDPgrowth | NICOME | TEQUITY |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $B_{it}$ | 1 | | | | | | | | | | |
| $AB_{it}$ | 0.005** | 1 | | | | | | | | | |
| LC | -0.090** | 0.005** | 1 | | | | | | | | |
| TD | 0.197** | 0.006** | -0.051** | 1 | | | | | | | |
| $S_{it}$ | -0.033** | -0.008** | -0.209** | -0.113** | 1 | | | | | | |
| SIZE | -0.218** | 0.007** | 0.333** | -0.305** | 0.112** | 1 | | | | | |
| Fed | 0.137** | -0.002 | 0.020** | 0.048** | 0.051** | -0.117** | 1 | | | | |
| Paperbill | -0.033** | 0 | 0.015** | -0.045** | 0.051** | 0.005** | 0.345** | 1 | | | |
| GDPgrowth | -0.086** | -0.002 | 0.062** | 0.020** | -0.011** | 0.027** | 0.129** | -0.062** | 1 | | |
| NICOME | 0.0001 | 0.00015 | -0.002 | -0.004* | -0.004** | -0.015** | 0.001 | 0 | 0 | 1 | |
| TEQUITY | -0.012** | 0.029** | 0.004** | 0.006** | 0.006** | 0.022** | 0.001 | 0.002 | 0 | 0 | 1 |

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

**Table 4: Bank liquidity reserve ($B_{it}$), bank loan portfolio liquidity ($S_{it}$), loan commitments (LC), transactions deposits (TD), the deposit-loan synergies (LC*TD), and bank's size: univariate tests.**

The table presents the univariate analysis of the relations between level of liquidity assets ($B_{it}$) and banks' size (measures by log of total asset), the bank-specific loan portfolio liquidity ($S_{it}$), the unused loan commitments ( LC), the transaction deposit (TD), the Deposit-Loan Synergies (LC*TD). Panel A presents the average liquidity assets ($B_{it}$) for four loans liquidity quartiles and the differential of liquid assets ($B_{it}$) between bank with more liquid and bank with less loans liquid. Panel B presents the average liquidity $B_{it}$ for four loan commitments (LC) quartiles and the differential of liquid assets ($B_{it}$) between banks with more liquid and banks with less unused loan commitment. Panel C presents the average liquidity $B_{it}$ for four transaction deposit (TD) quartiles and the differential of liquid assets ($B_{it}$) between banks with more liquid and banks with less transaction deposit. Panel D presents the average liquidity $B_{it}$ for four deposit-loan combination (LC*TD) quartiles and the differential of liquid assets ($B_{it}$) between banks with more liquid and banks with less Deposit-Loan synergies. Panel E presents the average liquidity $B_{it}$ for four size quartiles as well as the liquidity differential between banks in the largest and smallest size quartiles. The averages are computed for full sample 1997: I to 2010: IV, as well as for different sub-periods of the sample. The standard errors for the estimates of the averages for each group are reported. The *t-statistics* for differences in means are reported in brackets. *, **, and *** correspond to below 10%, 5%, and 1% significance of t-statistics, respectively.

| Panel A: Average liquidity $B_{it}$ across securitizability of loans ($S_{it}$) quartile (ratio) | | | | | |
|---|---|---|---|---|---|
| Securitizability of loans ($S_{it}$) quartiles | 1997:I - 2010:IV | 2001:IV | 2004:IV | 2007:IV | 2010:IV |
| Lowest Q1 $S_{it}$ | 0.326104 | 0.384925 | 0.287754 | 0.262913 | 0.323911 |
| | (0.00057) | (0.000856) | (0.001155) | (0.0012859) | (0.001) |
| Q2 | 0.299221 | 0.360982 | 0.280954 | 0.251783 | 0.258618 |
| | (0.00046) | (0.001) | (0.001) | (0.001) | (0.001) |
| Q3 | 0.301807 | 0.351676 | 0.29221 | 0.259317 | 0.248759 |
| | (0.00043) | (0.001) | (0.001) | (0.001) | (0.0010419) |
| Highest Q4 $S_{it}$ | 0.317185 | 0.348853 | 0.320111 | 0.284699 | 0.269131 |
| | (0.00045) | (0.001) | (0.001) | (0.001) | (0.001) |
| Q1-Q4 | 0.0089 | 0.0361 | -0.0324 | -0.0218 | 0.0548 |
| | [15,555]*** | [42,155]*** | [-28,016]*** | [-16,942]*** | [38,139]*** |
| Panel B: Average liquidity $B_{it}$ across loan commitments (*LC*) quartile (ratio) | | | | | |
| *LC* quartiles | 1997:I - 2010:IV | 2001:IV | 2004:IV | 2007:IV | 2010:IV |
| Lowest Q1 *LC* | 0.359809 | 0.406917 | 0.341913 | 0.315991 | 0.310623 |
| | (0.001) | (0.000858) | (0.0011802) | (0.001) | (0.001) |
| Q2 | 0.303705 | 0.350755 | 0.294753 | 0.259205 | 0.256824 |
| | (0.000) | (0.001) | (0.001) | (0.001) | (0.000978) |
| Q3 | 0.286048 | 0.337973 | 0.274526 | 0.238812 | 0.25404 |
| | (0.000) | (0.001) | (0.001) | (0.001) | (0.001) |
| Highest Q4 *LC* | 0.294473 | 0.352781 | 0.273612 | 0.238018 | 0.275539 |
| | (0.000) | (0.001) | (0.001) | (0.0010023) | (0.001) |
| Q1-Q4 | 0.0653 | 0.0541 | 0.0683 | 0.0780 | 0.0351 |
| | [119,021]*** | [63,063]*** | [57,871]*** | [66,155]*** | [25,911]*** |

| Panel C: Average liquidity $B_{it}$ across transactions deposits (*TD*) quartile (ratio) | | | | | |
|---|---|---|---|---|---|
| *TD* quartiles | 1997:I - 2010:IV | 2001:IV | 2004:IV | 2007:IV | 2010:IV |
| Lowest Q1 *TD* | 0.273517 | 0.330336 | 0.273707 | 0.239691 | 0.253399 |
| | (0.0005411) | (0.000782) | (0.001) | (0.001) | (0.0012541) |
| Q2 | 0.289564 | 0.339696 | 0.276163 | 0.229741 | 0.23134 |
| | (0.000) | (0.001) | (0.0009229) | (0.0008528) | (0.001) |
| Q3 | 0.319322 | 0.36314 | 0.300328 | 0.268042 | 0.273323 |
| | (0.000) | (0.001) | (0.001) | (0.001) | (0.001) |
| Highest Q4 *TD* | 0.361636 | 0.411845 | 0.330047 | 0.31998 | 0.338302 |
| | (0.000) | (0.001) | (0.001) | (0.001) | (0.001) |
| Q1-Q4 | -0.0881 | -0.0815 | -0.0563 | -0.0803 | -0.0849 |
| | [-162,864]*** | [-104,173]*** | [-51,480]*** | [-64,910]*** | [-67,699]*** |
| Panel D: Average liquidity measure $B_{it}$ across LC*TD (ratio) | | | | | |
| (LD*TD) quartiles | 1997:I - 2010:IV | 2001:IV | 2004:IV | 2007:IV | 2010:IV |
| Lowest Q1 | 0.329353 | 0.399627 | 0.338577 | 0.273218 | 0.279417 |
| | (0.0005805) | (0.00109) | (0.0017196) | (0.001) | (0.0014469) |
| Q2 | 0.294816 | 0.345095 | 0.287701 | 0.250162 | 0.248309 |
| | (0.000) | (0.001) | (0.001) | (0.001) | (0.001) |
| Q3 | 0.297562 | 0.345422 | 0.279777 | 0.252953 | 0.265537 |
| | (0.000) | (0.001) | (0.001) | (0.0009005) | (0.001) |
| Highest Q4 | 0.322304 | 0.366126 | 0.297619 | 0.277404 | 0.310741 |
| | (0.000) | (0.001) | (0.001) | (0.001) | (0.001) |
| Q1-Q4 | 0.0070 | 0.0335 | 0.0410 | -0.0042 | -0.0313 |
| | [12,143]*** | [30,731]*** | [23,818]*** | [-3,990]*** | [-21,649]*** |
| Panel E: Average liquidity measure $B_{it}$ across size quartiles (ratio) | | | | | |
| Size quartiles | 1997:I - 2010:IV | 2001:IV | 2004:IV | 2007:IV | 2010:IV |
| Small Q1 | 0.368501 | 0.412569 | 0.328462 | 0.31487 | 0.333909 |
| | (0.001) | (0.000809) | (0.0011099) | (0.0012452) | (0.001) |
| Q2 | 0.316021 | 0.363624 | 0.294693 | 0.268067 | 0.272285 |
| | (0.000) | (0.001) | (0.001) | (0.001) | (0.0010452) |
| Q3 | 0.288013 | 0.342708 | 0.277744 | 0.242896 | 0.250026 |
| | (0.0004334) | (0.001) | (0.001) | (0.001) | (0.001) |
| Large Q4 | 0.271546 | 0.326031 | 0.279887 | 0.23244 | 0.240771 |
| | (0.000) | (0.001) | (0.001) | (0.001) | (0.001) |
| Q1-Q4 | 0.0970 | 0.0865 | 0.0486 | 0.0824 | 0.0931 |
| | [180,946]*** | [106,932]*** | [43,767]*** | [66,197]*** | [70,408]*** |

## Table 5: Bank liquidity reserve (Bit) and its determinants in the full sample: multivariate analysis

The table presents the results of the ordinary least squares (OLS) regression analysis for the full sample. The dependent variable is the level of liquidity buffer (Bit); the independent bank-specific variables are loan liquidity (Sit), the unused loan commitments (LCit), transaction deposit (TDit), the deposit-loan synergies (LC*TDit), other control variables including the log of total assets (Sizeit), the equity capital to total assets (Equity Capitalit), the net income to total assets (Net Incomeit); and the independent aggregate variables are the Federal fund rate (Fedt) and the difference between the rates paid on 3-month prime-rated commercial papers and 120-day Treasury bills (Paperbillt) which are proxies for monetary policy, the GDP growth (GDPt) proxy for the business cycle, and the dummy variable Crisist to account for the recession period . The time fixed effects control the effects of changes in the regulation and other economic conditions on bank-specific variables. The t-statistic testing is conducted under the confidence level 90%, 95% and 99%, respectively.

| | H1 | H2 | | | H3 | | | H4 | | | (5a) | (5b) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (2a) | (2b) | (2c) | (3a) | (3b) | (3c) | (4a) | (4b) | (4c) | | |
| $S_{it}$ | -0.0112 | | | | | | | | | | -0.0038 | -0.0154 |
| | [-4.76]*** | | | | | | | | | | [-1.56] | [-6.50 ]*** |
| $LC_{it}$ | | -0.0294 | | 0.0486 | | | | | | | 0.0475 | 0.0410 |
| | | [-12.97]*** | | [16.26]*** | | | | | | | [15.49]*** | [13.24 ]*** |
| $TD_{it}$ | | | 0.1707 | 0.2401 | | | | | | | 0.2399 | 0.2473 |
| | | | [94]*** | [101.95]*** | | | | | | | [101.65]*** | [103.52]*** |
| $(LC*TD)_{it}$ | | | | -0.3915 | | | | | | | -0.3914 | -0.3851 |
| | | | | [-45.11]*** | | | | | | | [-45.1]*** | [-43.73]*** |
| $Fed_t$ | | | | | 0.0086 | | 0.0109 | | | | | 0.0121 |
| | | | | | [76.89]*** | | [91.32 ]*** | | | | | [ 102.08 ]*** |
| $Paperbill_t$ | | | | | | -0.0140 | -0.0352 | | | | | -0.0416 |
| | | | | | | [-22.78]*** | [-54.03 ]*** | | | | | [-62.03 ]*** |
| $GDP_t$ | | | | | | | | -5.1352 | -4.4901 | | | -5.4620 |
| | | | | | | | | [-54.07]*** | [-40.49 ]*** | | | [-49.86 ]*** |
| $Crisis_t$ | | | | | | | | | 0.0062 | 0.0178 | | 0.0143 |
| | | | | | | | | | [11.27 ]*** | [37.5]*** | | [25.21 ]*** |
| Bank-specific control variables | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Time fixed effect | Yes | Yes | Yes | Yes | No | No | No | No | No | No | Yes | No |
| OBS | 468,720 | 468,714 | 468,717 | 468,711 | 468,720 | 468,720 | 468,720 | 468,720 | 468,720 | 468,720 | 468,711 | 468,711 |
| Adjusted R-squared | 10.44% | 10.47% | 12.09% | 12.53% | 5.94% | 4.86% | 6.52% | 5.35% | 5.37% | 5.04% | 12.53% | 9.90% |

**Table 6: Bank liquidity reserve ($B_{it}$) and its determinants in two subsamples (small banks and large banks): robustness tests.**

The table presents the results of the ordinary least squares (OLS) regression analysis for two subsamples: small banks (bottom 75% in size) and large banks (top 5% in size). The dependent variable is the level of liquidity buffer ($B_{it}$); the independent bank-specific variables are loan liquidity ($S_{it}$), the unused loan commitments ($LC_{it}$), transaction deposit ($TD_{it}$), the deposit-loan synergies ($LC*TD_{it}$), other control variables including the log of total assets ($Size_{it}$), the equity capital to total assets ($Equity\ Capital_{it}$), the net income to total assets ($Net\ Income_{it}$); and the independent aggregate variables are the Federal fund rate ($Fed_t$) and the difference between the rates paid on 3-month prime-rated commercial papers and 120-day Treasury bills ($Paperbill_t$) which are proxies for monetary policy, the GDP growth ($GDP_t$) proxy for the business cycle, and the dummy variable $Crisis_t$ to account for the recession period. The time fixed effects control the effects of changes in the regulation and other economic conditions on bank-specific variables. The t-statistic testing is conducted under the confidence level 90%, 95% and 99%, respectively.

| | H1 | H2 | | | H3 | | | H4 | | | (5a) | (5b) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (2a) | (2b) | (2c) | (3a) | (3b) | (3c) | (4a) | (4b) | (4c) | | |
| Panel A: Regression results for small banks | | | | | | | | | | | | |
| $S_{it}$ | -0.0178 | | | | | | | | | | -0.0088 | -0.0242 |
| | [ -6.42 ]** | | | | | | | | | | [ -3.06]*** | [-8.66]*** |
| $LC_{it}$ | | -0.0479 | | 0.0083 | | | | | | | 0.0057 | -0.0082 |
| | | [-16.90]** | | [ 2.09]** | | | | | | | [1.41]* | [-2.01] |
| $TD_{it}$ | | | 0.2388 | 0.2831 | | | | | | | 0.2826 | 0.2822 |
| | | | [112.96 ]** | [105.14]*** | | | | | | | [104.77]*** | [103.41]** |
| $(LC*TD)_{it}$ | | | | -0.2784 | | | | | | | -0.2787 | -0.2697 |
| | | | | [ -25.16]** | | | | | | | [ -25.18]** | [-24.05]*** |
| $Fed_t$ | | | | | 0.0089 | | 0.0107 | | | | | 0.0120 |
| | | | | | [68.09]** | | [76.93]*** | | | | | [86.42]*** |
| $Paperbill_t$ | | | | | | -0.0071 | -0.0289 | | | | | -0.0369 |
| | | | | | | [-9.63]** | [ -36.86 ]** | | | | | [-46.05]*** |
| $GDP_t$ | | | | | | | | -5.7318 | -4.7939 | | | -5.8372 |
| | | | | | | | | [-51.0]** | [-36.59 ]** | | | [-45.49]*** |
| $Crisis_t$ | | | | | | | | | 0.0089 | 0.0210 | | 0.0137 |
| | | | | | | | | | [13.92]*** | [38.10]** | | [21.07]*** |
| Bank-specific control | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Time fixed effect | Yes | Yes | Yes | Yes | No | No | No | No | No | No | Yes | No |
| OBS | 351,492 | 351,492 | 351,492 | 351,492 | 351,492 | 351,492 | 351,492 | 351,492 | 351,492 | 351,492 | 351,492 | 351,492 |
| Adjusted R-squared | 11.05% | 11.11% | 14.16% | 14.44% | 7.21% | 6.02% | 7.57% | 6.68% | 6.73% | 6.38% | 14.44% | 12.12% |

| | H1 | | H2 | | H3 | | | H4 | | | (5a) | (5b) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (2a) | (2b) | (2c) | (3a) | (3b) | (3c) | (4a) | (4b) | (4c) | | |
| Panel B: Regression results for large banks | | | | | | | | | | | | |
| $S_{it}$ | -0.1016 | | | | | | | | | | -0.1235 | -0.1029 |
| | [-10.08 ]*** | | | | | | | | | | [-11.73]*** | [-10.03 ]*** |
| $LC_{it}$ | | -0.0674 | | -0.0078 | | | | | | | -0.0327 | -0.0127 |
| | | [-10.98]*** | | [-1.07] | | | | | | | [-4.31]** | [-1.68] |
| $TD_{it}$ | | | -0.0474 | 0.0947 | | | | | | | 0.0632 | 0.1143 |
| | | | [-5.87]*** | [7.68]*** | | | | | | | [5.02 ]*** | [ 9.12 ]*** |
| $(LC*TD)_{it}$ | | | | -0.3342 | | | | | | | -0.2879 | -0.3252 |
| | | | | [ -14.36]*** | | | | | | | [-12.23]*** | [-13.67]*** |
| $Fed_t$ | | | | | 0.0029 | | 0.0059 | | | | | 0.0081 |
| | | | | | [5.90]*** | | [11.53]*** | | | | | [15.14]*** |
| $Paperbill_t$ | | | | | | -0.0388 | -0.0484 | | | | | -0.0530 |
| | | | | | | [-15.57]*** | [-18.47]*** | | | | | [-19.14]*** |
| $GDP_t$ | | | | | | | | -2.3793 | -3.1047 | | | -3.4471 |
| | | | | | | | | [-5.93]*** | [-6.60]*** | | | [-7.26]*** |
| $Crisis_t$ | | | | | | | | | -0.0072 | 0.0012 | | 0.0054 |
| | | | | | | | | | [-2.95 ]*** | [0.59] | | [2.11]** |
| Bank-specific control variables | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Time fixed effect | Yes | Yes | Yes | Yes | No | No | No | No | No | No | Yes | No |
| OBS | 23,453 | 23,453 | 23,453 | 23,453 | 23,453 | 23,453 | 23,453 | 23,453 | 23,453 | 23,453 | 23,453 | 23,453 |
| Adjusted R-squared | 6.50% | 6.57% | 6.23% | 7.47% | 1.89% | 2.77% | 3.30% | 1.89% | 1.93% | 1.75% | 8.01% | 5.37% |

**Table 7: The alternative bank liquidity reserve ($AB_{it}$) and its determinants in full sample and subsamples: robustness tests.**

The table presents the results of the ordinary least squares (OLS) regression analysis for full sample and two subsamples: small banks (bottom 75% in size) and large banks (top 5% in size). The dependent variable is the level of liquidity buffer ($AB_{it}$) which is the ratio of liquid asets to total deposit; the independent bank-specific variables are loan liquidity ($S_{it}$), the unused loan commitments ($LC_{it}$), transaction deposit ($TD_{it}$), the deposit-loan synergies ($LC*TD_{it}$), other control variables including the log of total assets ($Size_{it}$), the equity capital to total assets ($Equity\ Capital_{it}$), the net income to total assets ($Net\ Income_{it}$); and the independent aggregate variables are the Federal fund rate ($Fed_t$) and the difference between the rates paid on 3-month prime-rated commercial papers and 120-day Treasury bills ($Paperbill_t$) which are proxies for monetary policy, the GDP growth ($GDP_t$) proxy for the business cycle, and the dummy variable $Crisis_t$ to account for the recession period . The time fixed effects control the effects of changes in the regulation and other economic conditions on bank-specific variables. The t-statistic testing is conducted under the confidence level 90%, 95% and 99%, respectively.

| | H1 | H2 | | | H3 | | | H4 | | | (5a) | (5b) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (2a) | (2b) | (2c) | (3a) | (3b) | (3c) | (4a) | (4b) | (4c) | | |
| Panel A: Regression results for full sample | | | | | | | | | | | | |
| $S_{it}$ | -15.1915 | | | | | | | | | | -16.9238 | -14.1763 |
| | [ -3.94]*** | | | | | | | | | | [ -4.19]*** | [ -3.65]*** |
| $LC_{it}$ | | -11.4970 | | 1.4585 | | | | | | | -3.4785 | -2.5492 |
| | | [ -3.05]*** | | [ 0.29] | | | | | | | [ -0.67] | [-0.49] |
| $TD_{it}$ | | | 20.9553 | 32.4249 | | | | | | | 30.8573 | 30.7986 |
| | | | [ 6.98 ]*** | [ 8.27]*** | | | | | | | [7.84]*** | [7.84 ]*** |
| $(LC*TD)_{it}$ | | | | -61.8819 | | | | | | | -60.4454 | -60.2125 |
| | | | | [ -4.32 ]*** | | | | | | | [ -4.22 ]*** | [-4.24]*** |
| $Fed_t$ | | | | | -0.0011 | | 0.0636 | | | | | 0.1825 |
| | | | | | [ -0.01] | | [ 0.34] | | | | | [ 0.95 ] |
| $Paperbill_t$ | | | | | | -0.8601 | -0.9847 | | | | | -0.9209 |
| | | | | | | [-0.89 ] | [-0.95] | | | | | [-0.85] |
| $GDP_t$ | | | | | | | | -268.0652 | -236.4231 | | | -264.9592 |
| | | | | | | | | [ -1.79 ]* | [-1.35 ] | | | [-1.50 ]* |
| $Crisis_t$ | | | | | | | | | 0.3049 | 0.9117 | | 0.4086 |
| | | | | | | | | | [ 0.35 ] | [ 1.23] | | [0.45 ] |
| Bank-specific control variables | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Time fixed effect | Yes | Yes | Yes | Yes | No | No | No | No | No | No | Yes | No |
| OBS | 466,736 | 466,736 | 466,736 | 466,736 | 466,736 | 466,736 | 466,736 | 466,736 | 466,736 | 466,736 | 466,736 | 466,736 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Adjusted R-squared | 0.11% | 0.11% | 0.12% | 0.12% | 0.10% | 0.10% | 0.10% | 0.11% | 0.11% | 0.10% | 0.13% | 0.12% |

| | H1 | H2 | | | H3 | | | H4 | | | (5a) | (5b) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (2a) | (2b) | (2c) | (3a) | (3b) | (3c) | (4a) | (4b) | (4c) | | |
| Panel B: Regression results for small banks | | | | | | | | | | | | |
| $S_{it}$ | -5.5087 | | | | | | | | | | -4.4194 | -4.0647 |
| | [-11.21]*** | | | | | | | | | | [-8.55]*** | [-8.17]*** |
| $LC_{it}$ | | 4.3392 | | 4.3513 | | | | | | | 3.0558 | 3.1556 |
| | | [ 8.64]*** | | [ 6.06]*** | | | | | | | [ 4.16]*** | [4.31]*** |
| $TD_{it}$ | | | 2.5435 | 2.4865 | | | | | | | 2.2390 | 2.2683 |
| | | | [ 6.68]*** | [ 5.12]*** | | | | | | | [ 4.60 ]*** | [ 4.67]*** |
| $(LC*TD)_{it}$ | | | | -0.6383 | | | | | | | -0.7928 | -0.7485 |
| | | | | [-0.32] | | | | | | | [-0.40] | [-0.37] |
| $Fed_t$ | | | | | 0.0306 | | 0.0295 | | | | | 0.0292 |
| | | | | | [ 1.36] | | [1.22] | | | | | [1.18] |
| $Paperbill_t$ | | | | | | 0.0768 | 0.0168 | | | | | 0.0768 |
| | | | | | | [ 0.61] | [0.12] | | | | | [0.54] |
| $GDP_t$ | | | | | | | | -19.5597 | -20.4870 | | | -36.8465 |
| | | | | | | | | [-1.01] | [-0.9]* | | | [-1.61]* |
| $Crisis_t$ | | | | | | | | | -0.0088 | 0.0428 | | -0.0382 |
| | | | | | | | | | [-0.08] | [0.45] | | [-0.33] |
| Bank-specific control variables | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Time fixed effect | Yes | Yes | Yes | Yes | No | No | No | No | No | No | Yes | No |
| OBS | 351,492 | 351,492 | 351,492 | 351,492 | 351,492 | 351,492 | 351,492 | 351,492 | 351,492 | 351,492 | 351,492 | 351,492 |
| Adjusted R-squared | 0.08% | 0.06% | 0.06% | 0.07% | 0.04% | 0.04% | 0.04% | 0.04% | 0.04% | 0.04% | 0.11% | 0.09% |

| | H1 | H2 | | | H3 | | | H4 | | | (5a) | (5b) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (2a) | (2b) | (2c) | (3a) | (3b) | (3c) | (4a) | (4b) | (4c) | | |
| Panel C: Regression results for large banks | | | | | | | | | | | | |
| $S_{it}$ | -44.4123 | | | | | | | | | | 64.9052 | 68.2969 |
| | [-0.62] | | | | | | | | | | [0.86] | [0.94] |
| $LC_{it}$ | | -121.1133 | | 65.4083 | | | | | | | 78.4970 | 73.48 |
| | | [-2.77]*** | | [1.26 ] | | | | | | | [ 1.45]* | [1.39]* |
| $TD_{it}$ | | | 367.3947 | 892.5844 | | | | | | | 909.1607 | 880.5937 |
| | | | [ 6.41]*** | [10.14]*** | | | | | | | [10.09]*** | [9.95]*** |
| $(LC*TD)_{it}$ | | | | -1262.237 | | | | | | | -1286.568 | -1272.103 |
| | | | | [-7.60]*** | | | | | | | [ -7.6]*** | [ -7.58]*** |
| $Fed_t$ | | | | | -6.0721 | | -5.8565 | | | | | -8.7578 |
| | | | | | [-1.81]* | | [ -1.65]* | | | | | [-2.32 ]** |
| $Paperbill_t$ | | | | | | -13.0892 | -3.5332 | | | | | 4.1281 |
| | | | | | | [-0.75] | [-0.19 ] | | | | | [0.21] |
| $GDP_t$ | | | | | | | | -4261.810 | -3531.291 | | | -982.941 |
| | | | | | | | | [-1.53] | [-1.08] | | | [-0.29] |
| $Crisis_t$ | | | | | | | | | 7.2331 | 16.792 | | 11.1906 |
| | | | | | | | | | [0.43] | [1.16] | | [0.62] |
| Bank-specific control variables | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Time fixed effect | Yes | Yes | Yes | Yes | No | No | No | No | No | No | Yes | No |
| OBS | 23,453 | 23,453 | 23,453 | 23,453 | 23,453 | 23,453 | 23,453 | 23,453 | 23,453 | 23,453 | 23,453 | 23,453 |
| Adjusted R-squared | 0.75% | 0.78% | 0.93% | 1.21% | 0.75% | 0.74% | 0.75% | 0.75% | 0.74% | 0.74% | 1.21% | 1.18% |