Bank Performance and the Liquidity Management

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Abstract

This paper investigates bank liquidity management and its effect on bank performance. Commercial banks tradeoff between holding liquid assets and investing risky assets to maximize the profits. Holding more liquid asset lowers liquidity risk of banks, but it also increases the operation costs and probably lowers profits made by banks. Therefore, we hypothesize that the liquidity management policy matters for bank performance. We analyze the bank data from Call Report from 1990 to 2015. Our results show that maintaining a suitable liquidity of a bank leads to better operating performance. However, when small banks holding a suitable level of liquidity usually face with lower stability. When facing economic downturns, small banks holding suitable amount of liquidity assets are vulnerable to the external market conditions and therefore increases the insolvency risks. Our study complements the literature about the bank liquidity management.

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1. Introduction

Many recent studies indicate that underestimating or ignorance of bank liquidity needs is one of the major reasons for financial crisis in 2007 in the U.S. and succeeding global financial crisis in late 2010 (Acharya and Naqvi, 2012; Bradbery, 2008; Fahlenbrach and Stulz, 2011; Loutskina, 2011). Commercial banks that serve as an intermediary of financial market disburse their payments to depositors when they withdraw from their accounts on a first-come, first-served basis and provide funds to borrowers via lines of credit or loan contracts by which borrowers could take out loans on demand over s specified period. Both activities create liquidity risk for banks that imbalanced cash flows occurred in asset and liability sides (Barth and Bennett, 1975; Diamond and Dybvig, 1983; Gatev, Schuermann, and Strahan, 2009; Rose and Hudgins, 2010). Therefore, banks are responsible for holding amount of liquidity asset to fit the needs of depositors and borrowers and avoid cash reserve strained to prevent bank runs. The more liquid assets banks hold, and the less liquidity risk they face. However, the liquid assets generally make lower returns for banks in comparison to risky assets that banks can ask higher interest payments for potential riskier borrowers and make profit from undertaking risks. Therefore, it is crucial for a bank to maintain a sufficient level of liquidity asset but also generate profits for the business. Although recent studies start emphasizing the importance of bank liquidity (Acharya and Naqvi, 2012; Bradbery, 2008; Fahlenbrach and Stulz, 2011; Loutskina, 2011; Morris and Shin, 2008), little studies have systematically examined the role of liquidity management for a bank and its impact on bank performance. Our study aims to fill in this gap.

We collect the bank-level data from the Federal Reserve's Report of Condition and Income ("call reports") submitted by insured banks from 1990 to 2015 and examine the determinants of bank liquidity for US banks. We find that the bank liquidity holdings are significantly affected by bank characteristics, such as the ratios of transactions deposits, unused loan commitments, the synergy effect of combining deposits-taking and loans-making activities, securitization, cost of deposits, income diversity, bank size, and market conditions. To capture how a bank manages its liquidity, we construct two measures. The first measure is the difference between the actual liquidity ratio and expected liquidity ratio estimated from the liquidity equation. The second measure is

the absolute value of the difference between the above-mentioned terms. If the difference between the actual liquidity ratio and expected liquidity ratio is closer to zero, those banks maintain a better and suitable liquidity level, indicating a better liquidity management. Therefore, we take a negative sign to the absolute value of the first measure to better capture the relationship between liquidity management and bank performance in the empirical analyses.

We find that when banks holding liquidity assets closer to expected liquidity ratio (hereafter, we define them as better liquidity management) have significantly higher operating performance. A better liquidity management is particularly important and contributes to operating performance for small banks. Commercial banks holding excess liquidity are observed to have poor bank operating performance. Because hoarding too much liquidity is costly for banks, banks holding excess liquidity reduce the reserve for lending, resulting in lowering profitability. This effect of poor liquidity management on operating performance is particularly evident for small banks.

We next examine the relationship between the bank liquidity management and bank risk-taking ability. We measure bank risk-taking by using *Log Z-score* and find that banks conducting a better liquidity policy are on average better able to take higher risks. The banks increase one standard deviation of the negative absolute value of the difference between the actual liquidity ratio and expected liquidity ratio is associated with higher *Log Z-score* of 0.005 (0.057 × 0.096). Specifically, this effect mainly stems from large banks. Different from large banks, small banks holding a suitable and sufficient level of liquidity have significantly lower Z-score and are vulnerable to insolvency risks.

We then investigate whether the liquidity management policy is affected by economic conditions. We find that when banks maintaining a better liquidity policy usually contribute a higher operating performance in economic upturns. However, if small banks adopting an efficient liquidity policy, the liquidity level close to the estimated liquidity level, they face with high insolvency risk in economic downturns, indicating that small banks holding suitable amount of liquidity assets are vulnerable to the external market conditions and therefore increases the insolvency risks.

Finally, we compare the interest expenses for the sample. We document that small banks have significantly higher interest expenses than large banks either in economic upturns or downturns. Higher cost of interest expenses of small banks may cause them

maintain lower level of liquid asset and make more loans, resulting in holding a riskier asset portfolio. The poor quality of loans may not increase bank vulnerability in the economic upturns, but significantly reduces risk-taking ability for small banks in economic downturns.

Our study contributes to the literature in three perspectives. First, as far as we know, we are the first one to systematically investigate the determinants of bank liquidity. Previous studies on bank liquidity usually focus on its unique role of liquidity provider (Kashyap, Rajan, and Stein, 2002) or strategies to manage liquidity risk (Gatev and Strahan, 2006; Gatev, Schuermann, and Strahan, 2007). Few studies investigate the potential factors for bank liquidity holdings, except the studies of Gatev, Schuermann, Strahan (2009), Kashyap, Rajan, and Stein (2002) and Loutskina (2011). They document that bank liquidity is associated with the level of transactions deposits, the level of loan commitments, or the level of bank securitized loans. Our study incorporates all potential variables for bank liquidity and systematically examine the determinants of bank liquidity policy.

Second, our study shed light on the importance of liquidity management of a bank. In this study we define a better liquidity policy as to minimize the real liquidity ratio and estimated liquidity for a bank and document that holding too much liquidity is costly for generating profits, although makes a bank less vulnerable. A better liquidity management policy that maintains sufficient amount of liquidity for liquidity needs could result in better operating performance. However, we also find that small banks conducting a sufficient liquidity policy also enhance profitability though increase their instability. Our study shows a tradeoff relationship between the profitability and stability for small banks.

Third, our study also complements the literature about how bank liquidity policies correspond to economic conditions. Previous studies indicate that the level of bank liquidity holding is affected by its strategic consideration under macroeconomic conditions (Acharya, Shin, and Yorulmazer, 2011; Granja, Matvos, and Seru, 2017; Shleifer and Vishny, 1992). Although risky assets generate higher cash flows and profits for banks, those cash flows become uncertain, risker, and illiquid under economic downturns as asset prices may fall below their fundamental value in adverse states (Allen and Gale 1998; Diamond and Dybvig, 1983). Contemplating the possibility of adverse consequences *ex ante*, banks may strategically hoard higher

liquidity than their optimal level. We find that small-size banks taking an efficient liquidity policy are more vulnerable during the business downturns, maintaining excess liquidity ensure them relatively stable. Meanwhile, large banks hoarding higher liquidity make higher profits, consistent with the strategic consideration suggested by Acharya, Shin, and Yorulmazer (2011) and Granja, Matvos, and Seru (2017).

The remainder of this paper proceeds as follows. Section 2 reviews prior literature and develops the main hypotheses. Section 3 describes the methodology. Section 4 provides the empirical results and Section 5 concludes.

2. Literature review and hypotheses development

Commercial banks that serve as an intermediary of financial markets engage in deposit-taking and lending activities to provide the liquidity to the market (Diamond and Dybvig, 1983; Diamond and Rajan, 2001; Holmström and Tirole, 1993; Kashyap, Rajan, and Stein, 2002). Because of this specific role, they are required to hold certain level of liquidity to meet the needs for depositors' withdrawal (Gatev, Schuermann, Strahan, 2009; Kashyap, Rajan, and Stein, 2002; Loutskina, 2011), needs for unexpected impediment of converting illiquid assets to liquid assets (Acharya, Shin and Yorulmazer, 2011; Klein, 1971), the difficulty of raising external finance (Barth and Bennett, 1975; Klein, 1971; Morris and Shin, 2008) and so on. Based on previous literature, we can categorize the needs for bank liquidity into transaction motive and precautionary motive and discuss the related studies in the following sections.

The transaction motive for bank liquidity holdings

Commercial banks receive deposits from individuals, business, or other institutions and make loans to their borrowing customers. These deposits – banks' main source of debts- are usually short-term cash and subject to a "sequential service constraint". That is, at any given point in time, banks need to disburse their payments when depositors withdraw from their accounts on a first-come, first-served basis. Meanwhile, banks also provide the funds to borrowers via lines of credit or loan contracts by using deposits received from the depositors. Because information asymmetry of financial market, financial intermediaries make profits by screening better loan applicants from ones with high risky borrowers (Calomiris and Kahn, 1991; Diamond and Rajan, 2001; Flannery, 1994; Gatev, Schuermann, and Strahan, 2009). Through this asset transformation, banks face with uncertainty of cash payments from

both sides of balance sheet and have to hold the liquid assets to mitigate the fluctuation of cash flows (Gatev, Schuermann, and Strahan, 2009).

Kashyap, Rajan, and Stein (2002) argue that loan commitments is a mechanism which behaves like a demand deposits because it allows borrowers to takedown the loan within a specified period. Therefore, deposits and loan commitments both share the feature of demand deposits, but with different cash flow streams (Barth and Bennett, 1975; Rose and Hudgins, 2010). Kashyap, Rajan, and Stein (2002) prove that loan lending and deposit-taking activities create the synergies for bank operation due to lowering cost of hoarding liquid assets to meet unpredicted liquidity needs. Gatev, Schermann and Strahan (2006, 2007) find that combining transactions deposits and loan commitments create synergy for a bank and reduces bank's liquidity demand as transactions deposits and loan commitments are not significantly correlated.

Securitization, converting illiquid assets into liquid securities, has grown tremendously in recent years. Banks can fund new loans by securitizing them to the market through this way, and hence it provides banks with a new source of financing their investment opportunities (Loutskina, 2011). When banks can easily convert illiquid loans into liquid assets, they do not need to hold a large amount of liquid assets to meet the unexpected liquidity demands from depositors and borrowers. Kashyap and Stein (2000) investigate the links between bank liquidity, cost of funds, and the loan supply under the effect of securitization and find that securitization made loan growth (especially business loans) less sensitive to cost of funds shocks. Therefore, the securitization mechanism reduces the level of liquid asset holdings.

Based on the above discussion, a bank with large transactional deposits or high level of unused loan commitments has higher fluctuation of their daily cash flows, therefore, is expected to demand higher level of liquidity. However, if there is higher synergy effect combining the transactional deposits and unused loan commitments of banks, we would expect that banks hold fewer liquid assets (Kashyap, Rajan, and Stein, 2002). Besides, banks with higher level of securitized loans are expected to maintain lower liquidity (Loutskina, 2011).

The precautionary motive for bank liquidity holdings

Commercial banks in the United States do not only provide traditional saving and lending services but also engage in a variety of activities, such as securities underwriting, brokerage and mutual fund services after the passage of the Gramm-

Leach-Bliley Act of 1999[1]. From the perspective of modern portfolio theory diversification could generate coinsurance effect across divisional cash flows, then it will reduce the return variance and further enhance the return of a portfolio of financial assets. One of the main benefits for banks entering into broader financial service activities is to diversify their operation risks to the cash flows or earnings (Johnson and Meinster, 1974; Deng and Elyasiani, 2005; Rose, 1989). For example, Deng and Elyasiani (2005) document that diversification of assets and non-traditional banking activities significantly reduces the volatility of bank earnings and hence decreases the bank risk. In addition, traditional banking activities are very sensitive to the changes in market interest rates. If banks diversify into non-traditional banking service, the fluctuation of cash flows from traditional banking division will decrease and thus reduce the need to hold excess liquidity for precautionary motive.

From efficient use of information perspective, banks acquire information about borrowers during the process of lending loans that facilitate the provisions of other non-traditional services, such as securities underwriting (Diamond, 1991; Rajan, 1992; Saunders and Walter, 1994). Involving more non-trading banking activities maximizes utilization of bank information. Holding too much liquid asset on hand will limit their ability of making loans or acquiring risky assets and decrease the profits efficiency. Meanwhile, bank diversification due to the information advantage might induce shareholders to take high risky loans for potential profitability (Demsetz and Strahan, 1997). This incentive reinforces with information advantage after bank diversification and aggravates the marginal cost of hoarding liquid assets. Since banks diversifying into non-traditional banking activities reduce the risk and create information advantage, they tend to hoard less liquidity compared to the banks involved in traditional banking activities.

However, Loutskina and Strahan (2009) document that mortgage lenders concentrated in few markets have superior information advantage on borrowers and enable to better price the risk of loans, therefore they can make higher profits through

[1] The Gramm–Leach–Bliley Act, also known as the Financial Services Modernization Act of 1999, expands the range of bank activities by removing barriers in the market among commercial banks, securities companies and insurance companies. Before the Gramm–Leach–Bliley Act, financial institutions are prohibited from acting as any combination of an investment bank, a commercial bank, and an insurance company. With the passage of the Gramm–Leach–Bliley Act, commercial banks, investment banks, securities firms, and insurance companies were allowed to consolidate.

involving more mortgage activities. Their study implies that concentrated lenders would hold less liquid assets than diversified lenders. If banks diversify, engaging in broader markets or businesses, they tend to rely on public information to screen the borrowers (Loutskina and Strahan, 2009). Due to less information advantage on borrowers, they would make less mortgages compared to concentrated lenders. Therefore based on Loutskina and Strahan (2009), we would expect that diversified banks hold relatively more liquidity because of their information disadvantage to screen the borrowers. Taken different views about banks diversification together, the effect of bank diversity to the liquidity holding is inclusive.

Banks' operations are very sensitive to changes in market conditions. When interest rates rise, for example, depositors may withdraw their funds in search of investment targets with higher rate of returns. Some loan borrowers may postpone new loan requests or speed up their drawings on the credit lines that carry lower interest rates (Rose and Hudgins, 2010). If their liquidity holdings are insufficient to meet their disbursement, they need to borrow funds from other banks with transaction cost or costly interests. An increase in liquidity hoarding mitigates the likelihood of bank cash deficiency (Klein, 1971; Kashyap, Rajan, and Stein, 2002). Therefore, banks would hold extra liquid assets to cope with unexpected sudden withdrawals either from depositors or loan borrowers (Barth and Bennett, 1975; Klein, 1971; Morris and Shin, 2008).

Acharya, Shin and Yorulmazer (2011) also indicate that hoarding liquid asset is affected by economic conditions. Compared to economic downturn, the pledgeability of risky cash flows is relatively higher so banks have stronger incentives to make profits by undertaking certain degree of risk and lower incentives to board liquid asset in economic upturns. On the other hand, the increase in the possibility of loss from investing risky assets and difficulty of access to external finance induce banks to hold more liquidity to cope with unexpected adverse shocks and capitalize on fire sales by failing banks. As the result, we would expect that banks are usually hold more liquid assets as a buffer stock on their balance sheet when the market condition is more volatile.

Bank size may also affect the level of liquidity holding. Kashyap, Rajan and Stein (2002) provide empirical evidence that the relationship between unused loan commitments and transactions deposits is different for banks of different size classes. Berger, Miller, Petersen, Rajan, and Stein (2005) argue that large and small banks have

comparative advantages in managing different types of credit information, and hence provide different types of loans. Berger and Bouwman (2009) show that banks with different size have various ability for liquidity creation. A bank with a high level of capital is better able to survive during the crisis. However, the effect of bank capital on bank liquidity creation for large banks and for small banks is different. Larger banks are better able to undertake risks and make loans, but small banks with more capital tend to invest more in liquid asset to avoid financial fragility. Thus, we also include bank size as one of the determinants for liquidity.

The relationship between bank liquidity and bank performance

Because the liquid assets and loans are two components of bank assets, investing in risky assets such as making loans enhances expected profits by increasing future cash flows but sacrifices the liquidity reserve to cope with unexpected withdrawals from depositors (Barth and Bennett, 1975; Diamond and Dybvig, 1983; Gatev, Schuermann, and Strahan, 2007, 2009; Kashyap, Rajan, and Stein, 2002). Therefore, it is a trade-off for banks between holding liquid assets and investing in risky assets (Acharya, Shin and Yorulmazer, 2011). Therefore, we suggest that there is an optimal liquidity policy for a given bank so as to generate a better operating performance. We provide the first hypothesis as below.

Hypothesis 1: Banks have higher operating performance when they maintain a suitable level of liquid assets.

Banks' decision of holding liquidity is not only associated with transaction needs but also affected by the precautionary motive. Banks face liquidity shortages or even bank run when they do not maintain sufficient liquidity to serve sudden and huge withdrawals from depositors and loan borrowers (Barth and Bennett, 1975; Klein, 1971; Morris and Shin, 2008). To avoid this possibility, banks would hold higher levels of liquid assets to reduce liquidity shocks either for cash flows uncertainties or changes in economic conditions.

When interest rates rise, for example, depositors may withdraw their funds in search of investment targets with higher rate of returns. Some loan borrowers may postpone new loan requests or speed up their drawings on the credit lines that carry lower interest rates (Rose and Hudgins, 2010). If their liquidity holdings are insufficient to meet their disbursement, they need to borrow funds from other banks with transaction cost or costly interests. An increase in liquidity assets holding mitigates the likelihood

of bank cash deficiency (Klein, 1971; Kashyap, Rajan, and Stein, 2002). Therefore, banks would hold extra liquid assets to cope with unexpected sudden withdrawals either from depositors or loan borrowers (Barth and Bennett, 1975; Klein, 1971; Morris and Shin, 2008). Based on discussions, we provide the second hypothesis below.

Hypothesis 2: Banks are able to take higher risks when they maintain a higher level of liquid assets.

3. Methodology

This section describes the data sources, variables, and summary statistics as follows.

3.1 Data sources

To analyze the performance of bank's liquidity management, we collect bank-level data from the Consolidated Report of Condition and Income (known as the Call Reports) on yearly basis. The market level data is collected from Federal Reserve Bank website. The sample period is from 1990 to 2015. We exclude the sample, if the sample's liquidity assets less than 0 or total assets less than 0 and the final sample contains 235250 bank-year data which covers 11062 banks. To mitigate extreme value effect, all variables are winsorized at 1% and 99% percentile.

3.2 Variables

Measures of bank liquidity ratio

Bank liquidity ratio, *LIQA*, is defined as the ratio of liquidity assets over the total assets (RCFD2170), where the liquidity asset is the sum of Fed funds sold and securities purchased under agreements to resell (RCFD1350), securities held to maturity (RCFD1754) and, available for sale securities (RCFD1773) (Kashyap and Stein, 2000).

Measures of liquidity management (LIQM)

As hoarding too much liquidity asset reduce loan making to borrowers and decreases bank profits, we define that a better liquidity policy for a bank is to minimize the difference between its real liquidity ratio and estimated value of liquidity ratio (*ELIQA*). We survey the literature and model the liquidity regression for the sample. The baseline liquidity specification is provided as equation (1).

$$LIQA_{i,t} = \alpha + \beta_i X_{i,t-1} + \varphi_{t-1} + \theta_i + \varepsilon_{i,t-1} \quad (1)$$

Where $LIQA_{i,t}$ is the liquidity ratio. $X_{i,t-1}$ is a vector of variables that may affect the liquidity. The determinant variables for liquidity include *Transactions deposits*, *Unused loan commitments*, *Deposit-loan synergies*, *Securitization*, *Cost of deposits*, *Income diversity*, *Log assets*, and *Paper-bill spread rate* (Acharya, Shin, and Yorulmazer, 2011; Berger and Bouwman, 2009; Foos, Norden, and Weber, 2010; Gatev and Strahan, 2006; Gatev, Schermann, and Strahan, 2007; Kashyap, Rajan, and Stein, 2002; Kashyap and Stein, 2000; Loutskina, 2011; Laeven and Levine, 2007).

We use a fixed effect model and add the time effect (φ_{t-1}) and firm effects (θ_i) in the regression to capture the unobserved effect at the firm level and in the same time trend and$\varepsilon_{i,t-1}$ is the residual term. The estimated value from the specification (1) is used as the optimum level for bank liquidity under different level of bank characteristics, a similar method been used in Mehran and Thakor (2011) and Miles, Yang, and Marcheggiano (2013) and others. To conduct the problem of correlation of the residuals within a cluster, we used clustered standard errors at the bank level to get unbiased estimates (Petersen, 2009).

Two variables are used to proxy for liquidity management. One is the difference between actual liquidity ratio (*LIQA*) and expected liquidity ratio (*ELIQA*) estimated from the baseline regression. This measure captures how banks manage their liquidity and whether excess liquidity contributes positive effect to bank performance. A smaller difference of actual liquidity ratio and expected liquidity ratio indicates that bank's liquidity level is closer to suitable level as model suggested. The difference between actual liquidity ratio and expected liquidity ratio could be negative, which reflects the actual liquidity ratio less than the expected liquidity ratio. As banks may hold excess or insufficient liquidity, larger difference between actual liquidity ratio and expected liquidity ratio has different implications. To explore the effect of a better liquidity policy, we adopt the second measure that takes absolute value of the first measure and multiply by -1. As smaller value of absolute term indicates a bank efficiently manages liquid asset, the smaller of the second term the better of liquidity policy.

The possible determinants of bank's liquidity

Several variables are included in the liquidity specification, such as *Transactions deposits*, *Unused loan commitments*, *Deposit-loan synergies*, *Securitization*, *Cost of deposits*, *Income diversity*, *Log assets*, and *Paper-bill spread rate. Transactions*

deposits is the ratio of total transactions deposits (RCON2215) divided by total deposits (RCFD2200) and *Unused loan commitments* is the ratio which calculated by amount of total unused loan commitments (RCFD3423) divided by sum of total unused loan commitments (RCFD3423) and total loans (RCFD1400). *Deposit-Loan Synergies* is the product of *Transactions deposits* and *Unused loan commitments*. The measure of *Securitization* is computed following Loutskina (2011) as a weighted average of the potential to securitize loans for six types (based on market-wide averages), in which the weights reflect the composition of an individual bank's loan portfolio. Six categories of loans include: (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[2]. The degree of loan liquidity for the six loan categories is computed as the ratio of loans securitized to total loans outstanding.

Bank diversity is measured by the extent to which banks engage in loan making activities or fee/trading-based activities. *Income diversity* is calculated by one minus the degree of bank income from interest earned of loan lending, therefore higher number indicating greater diversification (Laeven and Levine, 2007). Specifically, the ratio is defined as one minus the percentage of difference between net interest income and other operating income in the total operating income (RIAD4100). Net interest income is calculated by deducting interest expense (RIAD4073) from interest income (RIAD4107) and other operating income is the sum of income from trading assets (RIAD4169), income from Federal Funds sold (RIAD4020), and noninterest income (RIAD4079). *Cost of deposits* is the ratio as interest of deposits (RIAD4180) divided by total deposits (RCFD2200) to measure the cost of internal financing. We use the spread between the high-grade 3-month commercial paper rate and the 3-month treasury-bill rate (*Paper-bill spread rate*) to control for the market conditions (Gatev, Schuermann, and Strahan, 2009)

Previous studies indicate that bank size is one of important factors affecting the level of bank liquidity holding (Berger, Miller, Petersen, Rajan, and Stein, 2005; Berger

[2] A weight average of the potential to securitize loans of a give type, as used in Loutskina (2011), the measure is

$$Securitization = \sum_{j=1}^{6} \left(\frac{economy - wide\ securitzed\ loans\ of\ type\ j\ at\ time\ t}{economy - wide\ total\ loan\ outstanding\ of\ type\ j\ at\ time\ t} \right) \times share\ of\ type\ j\ loans\ in\ bank\ i\ portfolio\ at\ time\ t$$

and Bouwman, 2009; Kashyap, Rajan and Stein, 2002; Loutskina, 2011). Considering the size effect in association with liquidity policy, we separate the sample into two groups: large banks and small banks. Bank size is measured as the natural log of the bank total assets. If the bank's size is in the bottom 75% of the size distribution, it is defined as the small banks' group. If the bank's size is in the top 5% of the size distribution, then it is assigned to the large banks' group. Throughout the manuscript, we present our empirical results by the whole sample, small banks, and large banks, respectively.

Measurements of the bank's performance

We use two variables for bank performance. *Return on assets*, equals to net income (RIAD4340) divide to total assets (RCFD2170), is used to proxy for bank operating performance. *Log Z-score* equals the log value of the return on assets plus the capital asset ratio divided by the standard deviation of asset returns (Laeven and Levine, 2009). It indicates the distance to default that captures the bank's risk-taking ability. A higher Z-score indicates that the bank has lower probability of insolvency, and therefore is more stable. Because the Z-score is highly skewed, we take the natural logarithm of the Z-score in the empirical analysis. Table 1 presents the variable definitions about measures of liquidity management, bank performance, determinants of bank liquidity, and control variables use in the study.

[Insert Table 1 around here]

3.3 Summary statistics

Table 2 presents summary statistics of research variables for the sample. Panels A, B, and C present the summary statistics of the whole sample, small banks, and large banks, respectively. The mean (median) liquidity ratio for the sample is 0.198 (0.169) and the mean (median) *Log Z-score* for the sample is 3.699 (3.798). We also find the average liquidity ratio of small banks is larger than large banks. The mean (median) liquidity ratio for small banks are 0.189 (0.166) and 0.173 (0.144) for large banks, respectively. Our average liquidity ratio is lower than the ones reported in Loutskina (2011). This is probably due to shorter research period covered and liquidity value are relatively larger before 1990s. Our summary statistics about *Log Z-score* and *Return on assets* are similar to ones reported in Beltratti and Stulz (2012) Loutskina (2011).

[Insert Table 2 around here]

4. Empirical results

4.1 Determinants of bank liquidity

To investigate association between bank liquidity and bank performance, we first model the equation of bank liquidity. Then we estimate the predicted value of liquidity level for each sample bank for the baseline specification. We define that a bank conducts a better liquidity policy that minimize the difference between its true liquidity ratio and predicted value estimated from the baseline regression. We further use this measure to examine the relationship between bank liquidity policy and its performance in terms of accounting profitability and financial distress.

Table 3 presents the results of liquidity regression. We test the liquidity model using specification (1). Models 1 to 8 reports the empirical estimation by adding potential variable that may affect the bank liquidity level successively. The coefficients of *Transactions deposits* are significant and positive in all models, and the coefficients of *Unused loan commitments* are significant and positive in model 3 and model 5. The results are consistent with previous studies (Barth and Bennett, 1975; Diamond and Dybvig, 1983; Gatev, Schuermann, and Strahan, 2009). The coefficients of *Deposit-loan synergies* are negative in all models and significant, consistent with previous studies (Kashyap, Rajan and Stein, 2002; Gatev, Schermann and Strahan, 2006, 2007). The coefficients of *Securitization* are negative but not significant in models (4) to (6), but the coefficients become significantly negative in models (7) and (8) when we set the *Dummy of securitization* as a dummy variable equals one if a bank securitizes its loan, zero otherwise. Our evidence is consistent with Loutskina (2011). The estimated results of *Income diversity*, *Log assets*, and *Paper-bill spread rate* are consistent with previous studies (Acharya, Shin, and Yorulmazer, 2011; Berger and Bouwman, 2009; Gatev, Schermann, and Strahan, 2007; Kashyap, Rajan, and Stein, 2002; Loutskina, 2011).

From the empirical results of Table 3, we infer that the coefficients of all determinants in model (5) are consistently with the predicted directions as in previous studies so our baseline model describes the main determinants of bank liquidity well.

Therefore, we use model (5) in Table 3 to estimate the expected liquidity ratio (*ELIQA*).

[Insert Table 3 around here]

Then we use the expected liquidity ratio from model (5) of Table 3 to measure how a bank conducts its liquidity policy (*LIQM)*. The first is the difference between actual liquidity ratio (*LIQA*) and expected liquidity ratio (*ELIQA*) estimated from model (5) of the baseline regression. The second measure is to take absolute value of the first measure and multiply by -1. As smaller value of absolute term indicates a bank efficiently manages liquid asset, the smaller of the second term the better of liquidity policy.

Table 4 presents the summary statistics for the measures of liquidity management for all banks, small banks, and large banks, respectively. We find that the mean (median) *ELIQA* is 0.196 (0.198) for large banks, and 0.241 (0.24) for small banks, showing that large banks on average require lower liquidity level than small banks.[3] The mean (median) difference of actual liquidity ratio and expected liquidity ratio for large banks is -0.012 (-0.025) is smaller than the value of small banks. This evidence also indicates that large banks tend to hoard lower level of liquidity assets than small banks.

[Insert Table 4 around here]

4.2 The relationship between bank liquidity management and operating performance

We then use specification (2) to examine whether the bank holding liquidity assets closer to its expected liquidity ratio estimated from our liquidity model is associated with better bank performance.

$$Performance_{i,t} = \alpha + \beta LIQM_{i,t} + \gamma_i X_{i,t} + \varphi_t + \theta_i + \varepsilon_{i,t} \quad (2)$$

Where $Performance_{i,t}$ is *Return on assets* to measure bank's profitability and is *Log Z-score* measures risk-taking ability of bank i. $LIQM_{i,t}$ are two measures of bank

[3] Recall that the mean (median) *LIQA* is 0.173 (0.144) for large banks, and 0.189 (0.166) for small banks, respectively, in Table 2.

liquidity management. $X_{i,t-1}$ is a vector of the control variables of bank *i*, including *Deposits ratio*, *Loans ratio*, *Log assets*, *Income diversity*, and *Paper-bill spread rate* (Aebi, Sabato, and Schmid, 2012; Beltratti and Stulz, 2012; Ellul and Yerramilli, 2013). We use a fixed effect model to control the time effect by year dummies (φ_t) to capture effects that affected all firms in the same time and firm dummies (θ_i) to capture factors that affected firms in all times.$\varepsilon_{i,t}$ is the residual term. To conduct the problem of correlation of the residuals within a cluster, we used clustered standard errors at the bank level to get unbiased estimates.

[Insert Table 5 around here]

Table 5 presents the results. Again we present the results for whole sample, small banks, and large banks, respectively. Models (1), (3), and (5) report the results using negative absolute value of difference of actual liquidity ratio and expected liquidity ratio (-| $LIQA_{i,t}$ - $ELIQA_{i,t}$ |), and models (2), (4), and (6) report the results using the difference of actual liquidity ratio and expected liquidity ratio ($LIQA_{i,t}$ - $ELIQA_{i,t}$), respectively.

The coefficient of (-| $LIQA_{i,t}$ - $ELIQA_{i,t}$ |) in model (1) is positive and significant, suggesting that banks holding liquidity assets close to expected liquidity ratio have higher return on asset. The standard deviation of (-| $LIQA_{i,t}$ - $ELIQA_{i,t}$ |)for the sample banks is 0.096., which indicates that an increase in one standard deviation in (| $LIQA_{i,t}$ - $ELIQA_{i,t}$ |) is associated with higher *Return on assets* of 0.0096% (0.001 × 0.096). The coefficient of ($LIQA_{i,t}$ - $ELIQA_{i,t}$) in model (2) is significantly negative, suggesting that holding too much liquidity assets is detrimental to bank return on assets. The results are quite intuitive as banks hoarding too much reserves for liquidity purpose, then they will lower reserves for lending and reduce the probability of making profits. This effect is economically significant. As the standard deviation of the ($LIQA_{i,t}$ - $ELIQA_{i,t}$) for the sample banks is 0.166, an increase in one standard deviation in ($LIQA_{i,t}$ - $ELIQA_{i,t}$) decreases 0.332 % (0.002 × 0.166) of return on asset. Combining the results of models (1) and (2), we infer that holding excess liquidity assets is disadvantageous to bank operating performance. However, holding insufficient amount of liquidity assets may enhance the liquidity risk when customers withdraw their deposits or borrowers use loan commitments. Therefore, an optimal liquidity policy is crucial for bank operating

performance as shown in model (1) of Table 5.

The results observed from small banks are quite consistent with one observed from the whole sample. However, there is no significant relation between bank operating performance and liquidity management from the results in models (5) and (6). The possible reason for insignificant effect for large banks is that they have multiple sources of cash flows as they conduct different activities such as providing insurance services, investment advices, wealth consulting services etc.[4] As long as the cash flows from each different activities are not highly correlated, large banks are better able to form a diversified asset portfolio and lower the needs for liquidity asset (Demirgüç-Kunt and Huizinga, 2010; Diamond, 1991; Rajan, 1992; Saunders and Walter, 1994; Stein, 2002). Another possible reason is that large banks are better able to securitize their loans in the market and create the liquidity of their asset portfolio (Loutskina, 2011). As they are better able to manage the need for liquidity assets, it is possible that they keep lower level of liquidity asset and increase the size of risky asset investment to enhance the profitability. Therefore, an insignificant relationship is observed between liquidity assets and bank operating performance.

4.3 The relationship between bank liquidity management and bank risk-taking

Next we examine whether the liquidity policy of commercial banks affects its risking taking activities. We use *Log Z-score* as the measure for bank's risk-taking ability. We replace bank performance with *Log Z-score* in specification (2) and test our conjecture. The results are presented in Table 6. Similarly, we present the results for whole sample, small banks, and large banks, respectively. Models (1), (3), and (5) report the results using negative absolute value of difference of actual liquidity ratio and expected liquidity ratio (-| $LIQA_{i,t}$ - $ELIQA_{i,t}$ |), and models (2), (4), and (6) report the results using the difference of actual liquidity ratio and expected liquidity ratio ($LIQA_{i,t}$ - $ELIQA_{i,t}$), respectively.

[Insert Table 6 around here]

The coefficients of the (-|$LIQA_{i,t}$ - $ELIQA_{i,t}$|) in model (1) is positive and significant,

[4] We find that the average mean (median) value of *Income diversity* for large banks are small banks is 0.668 (0.691) and 0.541 (0.544), respectively. The evidence shows that the sources of cash flows for large banks are more diverse than small banks.

indicating that banks holding suitable and sufficient liquidity policy are on average better able to take higher risks. This effect is economically significant. As banks increase one standard deviation of the (-| $LIQA_{i,t}$ - $ELIQA_{i,t}$ |), *Log Z-score* is expected to increase by 0.5% (0.057 × 0.096). Banks holding excess liquidity assets are better able to take risks, as the coefficients of ($LIQA_{i,t}$ - $ELIQA_{i,t}$) of models (2), (4), and (6) are all significantly positive.

However, if we examine the results of models (3) and (5) for small banks and large banks, we find that the coefficients of (-| $LIQA_{i,t}$ - $ELIQA_{i,t}$ |) is significantly negative for small banks, but significantly positive for large banks, respectively. The inverse relation observed in model (3) suggests that small banks maintaining a suitable and sufficient level of liquidity policy are vulnerable to insolvency risks. Instead, if they hoard excess liquidity assets, they are better able to take higher risks from the evidence shown in model (4).

4.4 The relationship between bank liquidity management and bank performance under different economic conditions

So far we have documented that bank liquidity policy affects it operating performance and risk-taking ability. If banks hoard suitable and sufficient amount of liquidity, they perform better in terms of operating performance and are more stable. Abundant liquidity kept in the banks is detrimental to bank operating performance although enabling them take higher risks.

Though our findings so far are fruitful, we haven't considered the effect of the macroeconomic condition to the incentives of bank liquidity holding and its impact on bank performance as several studies indicate that banks' liquidity holding may be affected by the macroeconomic considerations (Acharya, et al., 2011; Ashcraft, 2006; Berger and Bouwman, 2009b; Campello, 2002; Demirgüç-Kunt and Huizinga, 2010; Holod and Peek, 2007; Kashyap and Stein, 2000). To explore this question, we identify the economic situation of U.S. market into two periods: upturns and downturns, where upturn period is that GDP growth rate is higher than the previous year and downturn period is the opposite condition, and conduct the empirical analyses as in Tables 5 and 6. Table 7 shows the results for liquidity policy to bank operating performance under economic upturns and downturns and Table 8 reports the results for liquidity policy to bank risk-taking level in different economic conditions.

[Insert Table 7 around here]

Panel A of Table 7 shows that the coefficients of (-| $LIQA_{i,t}$ - $ELIQA_{i,t}$ |) are significant and positive for the whole sample and small banks in economic upturns, indicating that holding suitable and sufficient liquidity assets on average leads to higher operating performance. This effect is particularly apparent for small banks. Panel B of Table 7 reports that the coefficients of ($LIQA_{i,t}$ - $ELIQA_{i,t}$) are significantly negative for the whole sample in economic upturns. The results are consistent with the findings in Table 5 that most of banks, in particular small banks, with excess liquidity have significantly worse operating performance in the economic upturns. However, we find that holding excess liquidity will generate higher operating performance in the economic downturns. This effect is particularly strong for large banks. One possible reason is that holding more liquid assets enable them to gain from acquiring asset at fire-sale prices, consistent with the Acharya, et al., 2011; Acharya and Naqvi, 2012; XXX.

From Panel A of Table 8 the coefficients of (-| $LIQA_{i,t}$ - $ELIQA_{i,t}$ |) are significantly positive for the whole sample in the upturns, indicating that banks holdings suitable and sufficient liquidity policy induce higher stabilty. When we examine the effects to banks with different sizes, we find that the positive effect exists in large banks, not in small banks. Instead, if small banks not holding excess liquidity during the economic downturns, they are usually more vulnerable and instable. In panel B of Table 8, we find that the coefficients of ($LIQA_{i,t}$ - $ELIQA_{i,t}$) are all significantly positive across all models, suggesting that banks holding more excess liquidity are better able to take risks. Our results are in the similar vein with Acharya and Naqvi (2012) that banks tend to take more risks when they have higher liquidity.

[Insert Table 8 around here]

4.5 The interest costs for different banks under different economic conditions

The above evidence indicates that banks with various sizes take different strategies in liquidity policies. Small banks holding excess liquidity make poor operating performance in the economic upturns while large banks holding excess liquid assets

make profits in the downturns. Because hoarding higher liquid assets decreases the amount of loan making given the deposits are fixed, therefore profits due to interest spread from deposits and lending reduce. That is, holding too much liquidity will increase interest expenses. Small banks compared with large banks are less able to have different sources of funds, which makes their interest expenses are relatively higher than large banks. Therefore, it is possible that small banks with suitable level of liquidity have higher operating performance than those with excess liquidity. Table 9 compares the average interest expense ratio for banks with different sizes in different economic conditions. The interest expense ratio is defined as the total interest expenses (RIAD 4073) divided by the total liabilities (RCD2948). We find that small bank's interest expense ratio is significantly higher than large banks either in economic upturns or downturns. In particular, the interest cost ratio for small banks in downturns are significantly higher than in upturns. Therefore, maintaining a minimum level of liquidity policy for small banks during economic downturns will make them vulnerable to increased market macroeconomic risks.

[Insert Table 9 around here]

5. Conclusion

This study investigates the importance of bank liquidity management and its impact on bank performance. We collect data from the Federal Reserve's Report of Condition and Income ("call reports") from 1990 to 2015 to explore the question.

We find that the bank liquidity holdings are significantly affected by bank characteristics, such as the ratios of *Transactions deposits*, *Unused loan commitments*, the synergy effect of combining deposits-taking and loans-making activities (*Deposit-Loan Synergies*), *Securitization*, *Cost of deposits*, *Income diversity*, *Log assets*, and economic condition (measured by *Paper-bill spread rate*). To capture how a bank manages its liquidity, we construct two measures of bank liquidity management.

We find that when banks holding liquidity assets closer to expected liquidity ratio have significantly higher operating performance. A better liquidity management is particularly important and contributes to operating performance for small banks. We also examine the relationship between the bank liquidity management and bank risk-taking. We measure bank risk-taking by *Log Z-score*. We find that when banks holding

higher level of liquidity assets, they usually have higher *Log Z-score*, indicating they are relatively safe and better able to undertake risks. We also find that an efficient liquidity policy helps large firms take higher risks, but not for small banks.

Finally, we link the relation between liquidity management and bank performance in different economic conditions. We find that when banks in economic upturns (measured by GDP growth rates), maintain a better efficient liquidity policy will contribute a better operating performance. However, bank' performance gets worse if they hoard too much liquidity in upturns. Interestingly, during economic downturns, holding more liquidity asset generally leads better operating performance. This phenomenon is particularly significant for large banks. Our study complements to the literature about the bank liquidity management.

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Table 1. Variable Definitions

Variable	Definition
1. Measurements of liquidity management	
Liquidity ratio (*LIQA*)	Liquidity ratio equals to sum of Fed funds sold and securities purchased under agreements to resell (RCFD1350), securities held to maturity (RCFD1754) and, available for sale securities (RCFD1773) divide to total assets (RCFD2170).
Expected liquidity ratio (E*LIQA*)	An expected value is calculated by fixed-effect model estimation.
2. Measurements of the bank's performance	
Return on assets	Return on assets equals to net income (RIAD4340) divide to total assets (RCFD2170).
Log Z-score	Log Z-score equals to natural log of return on assets plus capital ratio divide to standard deviation of return on assets.
3. Determinants of bank's liquidity ratio	
Transactions deposits	Transactions deposits is the ratio which equals to transactions deposits (RCON2215) divide to total deposits (RCFD2200).
Unused loan commitments	Unused loan commitments is the ratio which equals to unused loan commitments (RCFD3423) divide to sum of total unused loan commitments (RCFD3423) and total loans (RCFD1400).
Deposit-loan synergies	Deposit-loan synergies equals to Transactions deposits time Unused loan commitments.
Securitization	A weight average of the potential to securitize loans of a give type, as used in Loutskina (2011), the measure is $Securitization = \sum_{j=1}^{6} \left(\frac{economy - wide\ securitzed\ loans\ of\ type\ j\ at\ time\ t}{economy - wide\ total\ loan\ outstanding\ of\ type\ j\ at\ time\ t} \right) \times share\ of\ type\ j\ loans\ in\ bank\ i\ portfolio\ at\ time\ t$
Log assets	Natural log of total assets (RCFD2170).
Income diversity	Income diversity equals to one minus the difference of net interest income and non-interest income (RIAD4079)) divide to total operating income (RIAD4000). Net interest income is calculated by deducting interest expense (RIAD4073) from interest income (RIAD4107) and other operating income is the sum of income from trading assets (RIAD4169), income from Federal Funds sold (RIAD4020), and noninterest income (RIAD4079) (Laven and Levine, 2007).
Cost of deposits	Cost of deposits equals to interest of deposits (RIAD4180) divide to total deposits (RCFD2200).
Paper-bill spread rate	Paper-bill spread rate equals to the high-grade 3-month commercial paper rate minus the 3-month treasury-bill rate.
4. Control variables	
Deposits ratio	Deposits ratio equals to total deposits (RCFD2200) divide to total assets (RCFD2170).
Loans ratio	Loans ratio equals to total loans (RCFD1400) divide to total assets (RCFD2170).

Table 2. Summary Statistic for Research Variables

The table presents the summary statistic of research variables for the sample. Panels A, B, and C present the summary statistics of the whole sample, small banks, and large banks, respectively. All variables are defined in Table 1 and winsorized at the 1th and 99th percentiles.

	Number	Lower Quantile	Median	Upper Quantile	Mean	Standard Deviation
Panel A: All banks						
Liquidity ratio	235250	0.056	0.169	0.309	0.198	0.161
Return on assets	212417	0.006	0.010	0.013	0.009	0.008
Log Z-score	199823	3.155	3.798	4.364	3.699	0.914
Log assets	221482	10.643	11.426	12.318	11.555	1.230
Transactions deposits	235250	0.187	0.272	0.359	0.276	0.124
Deposits ratio	212907	0.818	0.866	0.897	0.848	0.066
Unused loan commitments	235250	0.044	0.097	0.159	0.109	0.082
Loans ratio	220745	0.496	0.616	0.715	0.596	0.157
Deposit-loan synergies	221919	0.010	0.023	0.042	0.029	0.024
Securitization	214889	0.194	0.303	0.411	0.296	0.160
Cost of deposits	212907	0.000	0.000	0.000	0.0005	0.001
Interest expense ratio	226247	0.018	0.029	0.038	0.0290	0.014
Income diversity	212321	0.488	0.567	0.641	0.564	0.128
Panel B: Small banks						
Liquidity ratio	69149	0.064	0.166	0.283	0.189	0.150
Return on assets	54010	0.005	0.009	0.013	0.008	0.008
Log Z-score	49959	3.103	3.775	4.331	3.666	0.920
Log assets	55381	9.835	10.153	10.520	10.181	0.480
Transactions deposits	69149	0.235	0.320	0.459	0.328	0.131
Deposits ratio	54159	0.834	0.875	0.901	0.857	0.064
Unused loan commitments	69149	0.000	0.044	0.105	0.066	0.072
Loans ratio	55097	0.435	0.563	0.670	0.550	0.161
Deposit-loan synergies	56190	0.004	0.017	0.035	0.024	0.023
Securitization	57124	0.084	0.273	0.419	0.264	0.194
Cost of deposits	54159	0.000	0.000	0.000	0.0002	0.001
Interest expense ratio	60518	0.017	0.028	0.038	0.028	0.014
Income diversity	53951	0.464	0.544	0.619	0.541	0.131
Panel C: Large banks						
Liquidity ratio	11062	0.048	0.144	0.260	0.173	0.150
Return on assets	8629	0.007	0.011	0.014	0.009	0.008
Log Z-score	8255	2.884	3.618	4.219	3.514	0.955
Log assets	11062	13.808	14.074	14.474	14.138	0.414
Transactions deposits	11062	0.079	0.121	0.228	0.166	0.113
Deposits ratio	8669	0.703	0.777	0.831	0.770	0.080
Unused loan commitments	11062	0.151	0.243	0.291	0.213	0.093
Loans ratio	10881	0.472	0.630	0.727	0.590	0.177
Deposit-loan synergies	11062	0.003	0.020	0.054	0.031	0.032
Securitization	11038	0.107	0.266	0.415	0.266	0.189
Cost of deposits	8403	0.000	0.002	0.004	0.002	0.002
Interest expense ratio	11038	0.015	0.024	0.037	0.026	0.015
Income diversity	8621	0.585	0.691	0.777	0.668	0.139

Table 3. Regressions Analyses on Determinants of Bank Liquidity

The table presents the results of the fixed-effect regression analyses for the sample from 1990 to 2015. The dependent variable is liquidity ratio (*LIQA*) which equals liquidity assets divided by total assets. All variables are defined as in Table 1 and winsorized at the 1th and 99th percentiles. Regression models include year fixed and firm fixed effects to control for the potential effects of changes in economic conditions on bank-specific variables. Robust t-statistics in parentheses are based on standard errors that are clustered by firm level. *, **, and *** correspond to below 10%, 5%, and 1% significance of t-statistics, respectively.

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Intercept	0.279	0.367	0.235	0.375	0.235	0.078	0.317	0.106
	(73.00)***	(103.83)***	(57.21)***	(110.62)***	(57.19)***	(33.58)***	(50.48)***	(29.96)***
Liquidity ratio $_{i,t-1}$						0.816		0.815692552
						(652.96)***		(652.51)***
Transactions deposits $_{i,t-1}$	0.162		0.241		0.241	0.057	0.239	0.057
	(52.68)***		(59.02)***		(59.03)***	(24.90)***	(58.52)***	(24.63)***
Unused loan commitments $_{i,t-1}$		-0.029	0.034		0.035	-0.035	0.002	-0.046
		(-7.09)***	(6.13)***		(6.15)***	(-11.00)***	(0.42)	(-13.76)***
Deposit-loan synergies $_{i,t-1}$			-0.371		-0.372	-0.061	-0.339	-0.050
			(-23.01)***		(-23.02)***	(-6.75)***	(-20.91)***	(-5.52)***
Securitization $_{i,t-1}$				-0.0001	-0.0001	-0.0001		
				(-0.87)	(-1.01)	(-0.04)		
Dummy of securitization $_{i,t-1}$							-0.085	-0.029
							(-17.31)***	(-10.58)***
Cost of deposits $_{i,t-1}$	-0.001	-0.001	-0.001	-0.001	-0.001	0.000	-0.001	0.000
	(-4.55)***	(-4.54)***	(-3.86)***	(-4.53)***	(-3.86)***	(-1.08)	(-4.36)***	(-1.38)
Income diversity $_{i,t-1}$	-0.037	-0.040	-0.039	-0.038	-0.039	-0.004	-0.047	-0.007
	(-18.45)***	(-18.89)***	(-18.38)***	(-18.48)***	(-18.37)***	(-3.70)***	(-21.75)***	(-5.95)***
Log assets $_{i,t-1}$	-0.004	-0.007	-0.001	-0.008	-0.001	-0.001	0.000	-0.001
	(-12.78)***	(-22.90)***	(-3.29)***	(-28.42)***	(-3.28)***	(-7.47)***	(-0.70)***	(-5.83)***
Paper-bill spread rate $_{i,t-1}$	-6.113	-6.451	-5.980	-6.502	-5.980	-3.916	-5.868	-3.878
	(-48.99)***	(-51.62)***	(-48.24)***	(-51.83)***	(-48.23)***	(-56.26)***	(-47.30)***	(-55.66)***
N	196184	195685	195685	196184	195685	195685	195685	195685
R-square	0.035	0.022	0.041	0.021	0.041	0.698	0.043	0.699
Fix effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 4. Summary Statistic for Bank Liquidity Management

The table presents the summary statistics for the measures of liquidity management for all banks, small banks, and large banks, respectively. The subsamples of "Small banks" are in the bottom 75% of the size distribution, and "Large banks" are in the top 5% of the size distribution. The liquidity ratio (*LIQA*) equals to liquidity assets divided by total assets. The expected liquidity ratio (*ELIQA*) is calculated from fixed effect regression of speciation (1). Two variables are used to proxy for liquidity management. One is the difference between actual liquidity ratio (*LIQA*) and expected liquidity ratio (*ELIQA*) estimated from the baseline regression. The second measure is to multiply absolute value of the first measure by -1. Panels A, B, and C present the results for the sample, small banks, and large banks, respectively.

	Number	Lower Quantile	Median	Upper Quantile	Mean	Standard Deviation
Panel A. All banks						
ELIQA	195685	0.210	0.230	0.251	0.230	0.034
LIQA - ELIQA	195685	-0.147	-0.031	0.094	-0.011	0.166
LIQA – ELIQA > 0	80714	0.0519	0.113	0.201	0.143	0.119
LIQA – ELIQA < 0	109149	-0.187	-0.134	-0.067	-0.129	0.073
-| *LIQA - ELIQA* |	195685	-0.192	-0.126	-0.060	-0.136	0.096
Panel B. Small banks						
ELIQA	51418	0.220	0.240	0.262	0.241	0.037
LIQA - ELIQA	51418	-0.151	-0.022	0.118	-0.011	0.180
LIQA – ELIQA > 0	21179	0.062	0.131	0.225	0.159	0.126
LIQA – ELIQA < 0	24793	-0.195	-0.142	-0.075	-0.137	0.076
-| *LIQA - ELIQA* |	51418	-0.204	-0.138	-0.069	-0.148	0.103
Panel C. Large banks						
ELIQA	8084	0.179	0.198	0.214	0.196	0.031
LIQA - ELIQA	8084	-0.133	-0.025	0.077	-0.012	0.161
LIQA – ELIQA > 0	3495	0.043	0.095	0.187	0.136	0.133
LIQA – ELIQA < 0	4589	-0.173	-0.118	-0.056	-0.116	0.069
-| *LIQA - ELIQA* |	8084	-0.176	-0.109	-0.049	-0.125	0.102

Table 5. Regression Analysis of Liquidity Management Effect on Bank Operating Performance

The table presents the results of the fixed-effect regression analysis for the sample from 1990 to 2015. The dependent variable is *Return on assets*. The subsamples of "Small banks" are in the bottom 75% of the size distribution, and "Large banks" are in the top 5% of the size distribution. All variables are defined as in Table 1 and winsorized at the 1th and 99th percentiles. Regression models include year fixed and firm fixed effects to control for the potential effects of changes in economic conditions on bank-specific variables. Robust t-statistics in parentheses are based on standard errors that are clustered by firm level. *, **, and *** correspond to below 10%, 5%, and 1% significance of t-statistics, respectively.

	All banks		Small banks		Large banks	
Model	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	0.032	0.032	0.059	0.055	0.022	0.022
	(48.01)***	(49.82)***	(19.41)***	(18.72)***	(8.99)***	(9.68)***
-| $LIQA_{i,t}$ - $ELIQA_{i,t}$ |	0.001		0.004		-0.001	
	(2.56)***		(2.86)***		(-0.56)	
$LIQA_{i,t}$ - $ELIQA_{i,t}$		-0.002		-0.006		0.002
		(-5.68)***		(-6.47)***		(1.70)
Return on assets $_{i,t-1}$	0.613	0.614	0.598	0.598	0.476	0.475
	(334.81)***	(334.87)***	(168.73)***	(168.78)***	(50.05)***	(49.75)***
Deposits ratio $_{i,t}$	-0.023	-0.023	-0.060	-0.060	-0.011	-0.011
	(-48.79)***	(-49.06)***	(-36.06)***	(-36.36)***	(-13.06)***	(-13.19)***
Loans ratio $_{i,t}$	-0.004	-0.005	-0.006	-0.008	0.000	0.001
	(-14.50)***	(-15.85)***	(-6.75)***	(-8.54)***	(-0.22)	(0.66)
Income diversity $_{i,t}$	0.005	0.005	0.007	0.007	0.003	0.004
	(29.76)***	(29.72)***	(15.75)***	(16.47)***	(7.12)***	(7.26)***
Log assets $_{i,t}$	-0.001	-0.001	-0.0002	0.0002	-0.001	-0.001
	(-22.08)***	(-21.07)***	(-0.99)	(0.65)	(-5.02)***	(-5.25)***
Paper-bill spread rate $_{i,t}$	-0.187	-0.179	-0.100	-0.059	-0.426	-0.432
	(-13.81)***	(-13.21)***	(-2.17)**	(-1.27)	(-9.32)***	(-9.42)***
N	204430	204430	51418	51418	8084	8084
R-square	0.388	0.388	0.416	0.416	0.302	0.302
Fix effect	Yes	Yes	Yes	Yes	Yes	Yes

Table 6. Regression Analysis of Liquidity Management Effect on Bank Stability

The table presents the results of the fixed-effect regression analysis for the sample from 1990 to 2015. The dependent variable is *Log Z-Score*. The subsamples of "Small banks" are in the bottom 75% of the size distribution, and "Large banks" are in the top 5% of the size distribution. All variables are defined as in Table 1 and winsorized at the 1th and 99th percentiles. Regression models include year fixed and firm fixed effects to control for the potential effects of changes in economic conditions on bank-specific variables. Robust t-statistics in parentheses are based on standard errors that are clustered by firm level. *, **, and *** correspond to below 10%, 5%, and 1% significance of t-statistics, respectively.

	All banks		Small banks		Large banks	
Model	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	1.154	1.099	1.067	1.144	1.177	0.887
	(52.94)***	(52.66)***	(19.49)***	(21.52)***	(9.10)***	(7.56)***
-| $LIQA_{i,t}$ - $ELIQA_{i,t}$ |	0.057		-0.090		0.277	
	(3.86)***		(-3.38)***		(3.37)***	
$LIQA_{i,t}$ - $ELIQA_{i,t}$		0.162		0.075		0.311
		(18.70)***		(4.72)***		(5.73)***
Log Z-Score $_{i,t-1}$	0.824	0.820	0.823	0.820	0.831	0.825
	(667.39)***	(653.75)***	(346.87)***	(337.69)***	(122.03)***	(119.04)***
Deposits ratio $_{i,t}$	-0.156	-0.124	-0.223	-0.225	-0.067	-0.010
	(-10.21)***	(-8.13)***	(-7.11)***	(-7.22)***	(-1.45)***	(-0.22)***
Loans ratio $_{i,t}$	-0.167	-0.064	-0.097	-0.083	-0.264	0.007
	(-18.17)***	(-6.95)***	(-5.69)***	(-4.80)***	(-5.05)***	(0.13)***
Income diversity $_{i,t}$	-0.064	-0.060	-0.029	-0.034	-0.016	0.002
	(-11.64)***	(-10.86)***	(-3.95)***	(-4.69)***	(-0.67)***	(0.10)***
Log assets $_{i,t}$	-0.017	-0.019	-0.0146	-0.0200	-0.016	-0.012
	(-17.24)***	(-19.25)***	(-3.32)***	(-4.44)***	(-2.64)***	(-2.08)***
Paper-bill spread rate $_{i,t}$	-1.816	-2.416	2.338	1.787	-23.761	-24.461
	(-4.41)***	(-5.86)***	(2.85)***	(2.16)**	(-10.36)***	(-10.68)***
N	189606	189606	47373	47373	7674	7674
R-square	0.709	0.709	0.729	0.729	0.668	0.669
Time effect	Yes	Yes	Yes	Yes	Yes	Yes
Firm effect	Yes	Yes	Yes	Yes	Yes	Yes

Table 7. Regression Analysis of Liquidity Management Effect on Bank Operating Performance in Different Economic Situations

The table presents the results of the fixed-effect regression analysis for the sample from 1990 to 2015. The dependent variable is *Return on assets*. The subsamples of "Small banks" are in the bottom 75% of the size distribution, and "Large banks" are in the top 5% of the size distribution. Up means that economic situation is in the period of upturn and Down means that economic situation is in the period of downturn. If the GDP growth rate in a given year is larger than the previous year, it is identified as an upward economic situation. Panel A presents the relation between *Return on assets* and absolute value of difference between actual liquidity ratio and expected liquidity ratio (-| *LIQA - ELIQA* |). Panel B reports the results for the difference between actual liquidity ratio and expected liquidity ratio (*LIQA - ELIQA*). All variables are defined as in Table 1 and winsorized at the 1th and 99th percentiles. Regression models include year fixed and firm fixed effects to control for the potential effects of changes in economic conditions on bank-specific variables. Robust t-statistics in parentheses are based on standard errors that are clustered by firm level. *, **, and *** correspond to below 10%, 5%, and 1% significance of t-statistics, respectively.

Panel A. absolute value of difference between actual liquidity ratio and expected liquidity ratio (-| *LIQA - ELIQA* |)						
Independent Variable	All banks		Small banks		Large banks	
	Up	Down	Up	Down	Up	Down
Intercept	0.037	0.025	0.076	0.013	0.010	0.025
	(39.74)***	(26.97)***	(17.62)***	(3.25)***	(4.26)***	(5.17)***
-| *LIQA - ELIQA* | $_{i,t}$	0.003	0.0001	0.008	0.0032	-0.003	-0.006
	(3.97)***	(0.16)	(3.71)***	(1.47)	(-1.56)	(-1.50)
Return on assets $_{i,t-1}$	0.558	0.696	0.523	0.712	0.465	0.366
	(224.80)***	(266.42)***	(107.51)***	(148.04)***	(44.37)***	(24.45)***
Deposits ratio $_{i,t}$	-0.029	-0.017	-0.081	-0.035	-0.007	-0.016
	(-44.87)***	(-25.79)***	(-34.28)***	(-16.43)***	(-8.64)***	(-9.35)***
Loans ratio $_{i,t}$	-0.004	-0.004	-0.007	-0.005	0.0058	-0.004
	(-9.10)***	(-9.37)***	(-4.94)***	(-3.97)***	(6.00)***	(-1.90)
Income diversity $_{i,t}$	0.006	0.005	0.005	0.016	0.005	0.002
	(25.88)***	(14.87)***	(11.24)***	(15.28)***	(8.84)***	(2.54)***
Log assets $_{i,t}$	-0.001	-0.001	-0.0001	0.001	-0.0003	-0.001
	(-14.55)***	(-17.58)***	(-0.14)	(3.94)***	(-2.82)***	(-2.26)**
Paper-bill spread rate $_{i,t}$	0.036	-0.086	0.327	-0.052	-0.1296	-0.253
	(1.36)	(-5.49)***	(3.39)***	(-1.04)	(-2.10)**	(-3.29)***
N	88462	115968	22296	29122	5253	3194
R-square	0.333	0.495	0.348	0.569	0.368	0.213
Time effect	Yes	Yes	Yes	Yes	Yes	Yes
Fix effect	Yes	Yes	Yes	Yes	Yes	Yes
Panel B. Bank's difference of actual liquidity ratio						
Intercept	0.036	0.025	0.064	0.012	0.012	0.027
	(41.69)***	(27.06)***	(15.11)***	(3.01)***	(5.25)***	(5.91)***
LIQA - ELIQA $_{i,t}$	-0.006	0.0015	-0.015	0.0005	0.0002	0.0053
	(-13.99)***	(3.41)***	(-11.03)***	(0.36)	(0.17)	(2.09)**
Return on assets $_{i,t-1}$	0.558	0.695	0.521	0.711	0.466	0.364
	(224.89)***	(266.25)***	(107.23)***	(147.97)***	(44.22)***	(24.29)***
Deposits ratio $_{i,t}$	-0.030	-0.017	-0.083	-0.034	-0.008	-0.016
	(-45.75)***	(-24.84)***	(-34.99)***	(-16.13)***	(-8.94)***	(-9.27)***
Loans ratio $_{i,t}$	-0.006	-0.003	-0.013	-0.004	0.005	-0.003
	(-14.56)***	(-7.15)***	(-9.16)***	(-2.98)***	(5.12)***	(-1.37)
Income diversity $_{i,t}$	0.006	0.005	0.006	0.016	0.005	0.002
	(25.88)***	(15.23)***	(12.62)***	(15.30)***	(8.48)***	(2.67)***
Log assets $_{i,t}$	-0.001	-0.001	0.001	0.001	-0.0004	-0.001
	(-12.22)***	(-17.92)***	(3.30)***	(3.63)***	(-3.08)***	(-2.78)***
Paper-bill spread rate $_{i,t}$	0.179	-0.082	0.861	-0.046	-0.136	-0.238
	(6.30)***	(-5.22)***	(7.95)***	(-0.93)	(-2.18)**	(-3.08)***
N	88462	115968	22296	29122	5253	3194
R-square	0.334	0.496	0.350	0.568	0.367	0.214
Time effect	Yes	Yes	Yes	Yes	Yes	Yes
Firm effect	Yes	Yes	Yes	Yes	Yes	Yes

Table 8. Regression Analysis of Liquidity Management Effect on Bank Stability in Different Economic Situations

The table presents the results of the fixed-effect regression analysis for the sample from 1990 to 2015. The dependent variable is *Log Z-Score*. The subsamples of "Small banks" are in the bottom 75% of the size distribution, and "Large banks" are in the top 5% of the size distribution. Up means that economic situation is in the period of upturn and Down means that economic situation is in the period of downturn. If the GDP growth rate in a given year is larger than the previous year, it is identified as an upward economic situation. Panel A presents the relation between Return on assets and absolute value of difference between actual liquidity ratio and expected liquidity ratio (-| LIQA - ELIQA |). Panel B reports the results for the difference between actual liquidity ratio and expected liquidity ratio (*LIQA - ELIQA*). All variables are defined as in Table 1 and winsorized at the 1th and 99th percentiles. Regression models include year fixed and firm fixed effects to control for the potential effects of changes in economic conditions on bank-specific variables. Robust t-statistics in parentheses are based on standard errors that are clustered by firm level. *, **, and *** correspond to below 10%, 5%, and 1% significance of t-statistics, respectively.

Independent Variable	All banks		Small banks		Large banks	
	Up	Down	Up	Down	Up	Down
Panel A. Bank's absolute difference of actual liquidity ratio						
Intercept	0.823	1.385	0.848	1.253	0.562	1.286
	(27.45)***	(44.18)***	(10.39)***	(15.74)***	(4.89)***	(4.95)***
-| *LIQA - ELIQA* | $_{i,t}$	0.053	0.031	-0.038	-0.128	0.256	0.025
	(2.67)***	(1.44)	(-1.01)	(-3.39)***	(3.26)***	(0.12)
Log Z-Score $_{i,t-1}$	0.823	0.825	0.817	0.823	0.842	0.833
	(483.48)***	(469.10)***	(235.83)***	(247.24)***	(136.79)***	(58.36)***
Deposits ratio $_{i,t}$	-0.125	-0.219	-0.248	-0.272	0.090	-0.258
	(-5.99)***	(-10.06)***	(-5.48)***	(-6.17)***	(2.13)**	(-2.78)***
Loans ratio $_{i,t}$	-0.031	-0.252	-0.048	-0.148	-0.100	-0.335
	(-2.39)**	(-19.72)***	(-1.90)	(-6.37)***	(-2.21)**	(-3.43)***
Income diversity $_{i,t}$	-0.041	-0.139	-0.020	-0.123	-0.063	0.007
	(-6.80)***	(-12.40)***	(-2.68)***	(-5.63)***	(-2.20)**	(0.17)
Log assets $_{i,t}$	-0.0003	-0.026	0.006	-0.022	0.006	-0.021
	(-0.21)	(-18.49)***	(0.89)	(-3.60)***	(1.11)	(-1.68)
Paper-bill spread rate $_{i,t}$	10.073	-2.196	12.346	1.391	4.799	-24.914
	(13.18)***	(-4.15)***	(7.32)***	(1.36)	(1.69)	(-6.39)***
N	82524	107082	20741	26632	4967	3010
R-square	0.744	0.686	0.736	0.725	0.797	0.544
Time effect	Yes	Yes	Yes	Yes	Yes	Yes
Firm effect	Yes	Yes	Yes	Yes	Yes	Yes
Panel B. Bank's difference of actual liquidity ratio						
Intercept	0.774	1.344	0.897	1.340	0.379	1.246
	(27.13)***	(44.43)***	(11.15)***	(17.25)***	(3.58)***	(5.21)***
LIQA - ELIQA $_{i,t}$	0.138	0.150	0.061	0.047	0.189	0.309
	(10.49)***	(12.30)***	(2.44)**	(2.13)**	(3.80)***	(2.32)**
Log Z-Score $_{i,t-1}$	0.820	0.821	0.815	0.821	0.839	0.824
	(475.08)***	(460.12)***	(230.47)***	(242.13)***	(133.90)***	(56.55)***
Deposits ratio $_{i,t}$	-0.103	-0.182	-0.247	-0.280	0.123	-0.232
	(-4.94)***	(-8.32)***	(-5.49)***	(-6.33)***	(2.94)***	(-2.48)***
Loans ratio $_{i,t}$	0.073	-0.176	-0.022	-0.158	0.065	-0.209
	(5.28)***	(-13.84)***	(-0.82)	(-6.76)***	(1.38)	(-2.02)**
Income diversity $_{i,t}$	-0.039	-0.127	-0.023	-0.125	-0.025	0.013
	(-6.65)***	(-11.30)***	(-3.18)***	(-5.72)***	(-0.85)	(0.34)
Log assets $_{i,t}$	-0.002	-0.028	0.002	-0.026	0.007	-0.023
	(-1.50)	(-20.01)***	(0.24)	(-4.22)***	(1.24)	(-1.90)
Paper-bill spread rate $_{i,t}$	7.569	-2.412	10.772	0.987	3.312	-23.866
	(9.50)***	(-4.56)***	(5.91)***	(0.97)	(1.15)	(-6.08)***
N	82524	107082	20741	26632	4967	3010
R-square	0.744	0.687	0.736	0.725	0.797	0.544
Time effect	Yes	Yes	Yes	Yes	Yes	Yes
Firm effect	Yes	Yes	Yes	Yes	Yes	Yes

Table 9. Average Interest Expense Ratios in Different Sizes

This table presents the average interest expense ratio for banks with different sizes. The sample period is from 1990 to 2015. Interest expense ratio equals to total interest expense divide to total liabilities. The subsamples of "Small banks" are in the bottom 75% of the size distribution, and "Large banks" are in the top 25% of the size distribution. Up means that economic situation is in the period of upturn and Down means that economic situation is in the period of downturn. If the GDP growth rate in a given year is larger than the previous year, it is identified as an upward economic situation. *, **, and *** correspond to below 10%, 5%, and 1% significance of t-statistics, respectively.

	Economic situation			
Bank size	1990 to 2015	Up	Down	Down-Up
Small banks	0.0283	0.0261	0.0303	0.0042
	(482.75)***	(367.97)***	(338.41)***	(35.97)***
Large banks	0.0263	0.0236	0.0288	0.0053
	(185.56)***	(140.98)***	(132.78)***	(18.91)***
Small banks - Large banks	0.0020	0.0025	0.0015	
	(12.96)***	(13.79)***	(6.54)***	