Analysis of the Liquidity Situation of the U.S. Banking System in Light of the 2023 Bank Failures

Lilla Tünde Sáfi[1] **– Gábor Kürthy**[2]

ABSTRACT: The closure of U.S. banks in the spring of 2023 stemmed from a complex interplay of factors. In hindsight, it is possible to identify the macroeconomic trends, balance sheet distortions, and management shortcomings that contributed to the crisis. However, accurately predicting which banks would fail, even with enhanced supervisory oversight, would have been highly unlikely. This study examines whether changes in liquidity—specifically the liquidity coverage ratio (LCR)—could have provided early warning signs of potential problems before the second quarter of 2023. While the analysis does not focus on individual banks, it explores whether signs of distress within a specific group of banks could have alerted regulators. Using publicly available data from the Federal Deposit Insurance Corporation (FDIC), the study employs an estimation method to calculate LCRs based on bank size. The findings reveal three key insights: first, the estimation method is effective, as it closely approximates actual LCR data from large banks' reports; second, the model successfully identified potential liquidity issues within the group of banks in which some banks ultimately experienced failure; and third, the analysis shows that the liquidity crisis, which coincided with significant interest rate hikes, has since subsided.
KEYWORDS: Liquidity Coverage Ratio (LCR), U.S. Banking System, Bank Failures, Liquidity Risk, Regulatory Oversight
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Introduction and Objective

In the spring of 2023, four U.S. banks ceased operations: Silvergate Bank voluntarily suspended its activities, while the Federal Deposit Insurance Corporation (FDIC) intervened to close Silicon Valley Bank, Signature Bank, and First Republic Bank,

1 Lilla Tünde Sáfi, MSc, Independent Researcher, email: safi.lilla2000@gmail.com
2 Gábor Kürthy, PhD, Corvinus University of Budapest, email: gabor.kurthy@uni-corvinus.hu

taking control of their assets and liabilities. Since these events, several studies (e.g., Király-Mikolasek, 2023a) have explored the underlying causes of the closures. Despite operational differences among the four institutions, common factors contributing to their failures can be identified. The closures were triggered by a run on deposits, which differed from the traditional image of small depositors lining up outside bank branches. Instead, large depositors sparked the panic by withdrawing their deposits. This phenomenon aligns with the "bank panic" model described by Diamond and Dybvig (1983), in which depositors with a healthy liquidity rush to withdraw their deposits due to negative news about the banks or the broader banking system. Under the traditional banking model, no institution engaged in maturity transformation can withstand such large-scale deposit withdrawals. Only a so-called "narrow bank," maintaining 100% liquidity reserves, would be immune to this type of crisis (Király-Mikolasek, 2023b).

A "classical" banking system operates through the simultaneous creation of loans and deposits. When a loan is issued, the necessary funds are already available, meaning the bank does not need to collect deposits beforehand. As the borrower spends the money, the deposit created by the loan flows to other banks, taking liquidity away from the lending bank. In a sufficiently diversified banking system, where other banks are also issuing loans, these liquidity outflows are typically offset by corresponding inflows, maintaining overall liquidity stability. The original deposit used to finance the loan becomes dispersed, ending up in the current accounts of suppliers, employees, and the Treasury. Small depositors utilize their accounts for payments and receive deposits into their accounts. If a bank's customer base is diverse, its liquidity inflows and outflows generally balance each other. Under normal conditions, banks can address liquidity surpluses by lending to the interbank market or cover shortages by borrowing through the same channels. This framework facilitates maturity transformation, where long-term loans are financed by short-term, demand deposits that depositors can withdraw or use for payments at any time (Riesz, 1980).

However, achieving the idealized operation of this banking model is challenging, even with regulation, particularly when banks primarily focus on maturity and risk transformation (Ábel-Mérő, 2024). Prior to the U.S. bank failures, the banking model exhibited several fundamental flaws. The customer base was not heterogenous, resulting in excessively concentrated loan (asset) and deposit portfolios. This issue was not merely due to technology-sector firms borrowing large sums while keeping deposits within a narrow banking network. More importantly, a significant portion of the deposits had not been created through lending but were instead injected into the banking system during the post-COVID liquidity surge driven by government and central bank interventions (Acharya et al., 2023). In this context, the initial changes to bank balance sheets resembled those of "fake" banking models, where customers effectively lend money to the bank before the bank lends it out. On the asset side, central bank reserves increase, while on the liability side, customer deposits grow. Banks then use their excess reserves to purchase long-term government bonds. At this point, the balance sheet mirrors the classical model: long-term loans (typically to government or government-backed entities), on the asset side, and short-term demand deposits on the liability side.

Before the 2008 financial crisis, U.S. shadow banks had also developed similar balance sheets, financing securitized loans through loans raised in the wholesale money market (Mehrling, 2011). The critical difference, however, was that while in the classical banking model, deposits financing the assets were primarily operating deposits by non-institutional clients, shadow banks managed the risks of securitized loans using interest rate derivatives, believing to create a synthetic short-term portfolio of government securities. In this model, market liquidity was provided by companies issuing credit default swaps (CDSs), notably AIG (American International Group). When these CDSs were found to be mispriced, market liquidity has disappeared, leading to the collapse of the system (Mehrling, 2011). In the 2023 case, however, banks did not need to hedge against credit risk but neglected interest rate risk. When interest rate shocks materialized, the (perceived) liquidity of deposits vanished, leading to the collapse of these banks.

Following the 2008 financial crisis, global regulatory measures were introduced to mitigate the risk of bank liquidity crises, including the adoption of the Liquidity Coverage Ratio (LCR). The LCR measures a bank's capacity to meet potential short-term liquidity outflows over a 30-day period by comparing them to its potential inflows. Simply put, a bank with an LCR of 100% or higher is considered capable of meeting its liquidity needs for 30 days using its balance sheet funds, including off-balance sheet assets. However, this framework rests on the implicit assumption that liquidity withdrawal does not become a self-reinforcing process—in other words, that a bank can manage a gradual reduction in liquidity without sparking a broader panic among depositors or creditors (such as other banks) rushing to withdraw their money before it's too late (Duffie, 2024).

At the institutional level, the LCR and other financial ratios serve as signal of a bank's liquidity position, providing valuable insights for supervisors, wholesale creditors, and uninsured depositors. However, these ratios are not infallible and do not guarantee a bank's survival. For non-public companies, such indicators may not even be disclosed. On the other, it can be argued that LCR should not be published at all, as misinterpretation of the ratio could potentially incite unnecessary panic (Cetina-Gleason, 2015). When a bank reaches a certain scale or systemic importance, its liquidity challenges extend beyond the institution itself, as its failure can have significant spillover effects on the broader financial system. Consequently, the key question is not whether the evolution of the LCR or similar indicators can predict the failure of specific banks, but whether these indicators can highlight the potential for broader systemic instability and an increased probability of failure. It is possible that liquidity issues at Silicon Valley Bank (SVB) were apparent as early as 2022. However, if the focus had been solely on meeting specific indicator thresholds, such problems might have been managed through adjustments to the bank's business model or portfolio restructuring, avoiding the need for more drastic measures (Tuckman, 2023).

Indeed, compliance with point-in-time (PIT) requirements can be manipulated through practices such as window dressing, where reported liquidity positions are artificially enhanced using repurchase agreements (repos), interbank loans, or even accounting adjustments. A 2014 report by the Federal Reserve's Board of Governors highlighted a similar concern, noting that the stock of high-quality liquid assets at a specific point in time is susceptible to manipulation. The report suggested that this issue could be mitigated by averaging data over a longer time horizon (Fed, 2014). Looking at a broader range of financial ratios, there were no immediate signs of financial distress among banks in 2022. Indicators such as capital situtions and profitability did not point to imminent failure (Király-Mikolasek, 2023a). Moreover, the shift in the structure of banks' balance sheets can be linked to broader economic policy measures introduced following the COVID crisis in 2020 (Acharya et al., 2023).

Systemic liquidity adequacy, as reflected by these metrics, is more resilient to the types of manipulation that may be possible at the individual bank level. For instance, when Bank X borrows federal funds from Bank Y for a term longer than 30 days, Bank X's liquidity position appears to improve, while Bank Y's liquidity position deteriorates. Bank Y may still appear to be compliant, even though the funds it lent out are being used by Bank X to maintain its own position. At the systemic level, however, the overall liquidity situation remains unchanged. This dynamic is also evident in other banking practices, such as repos and off-balance-sheet transactions.

This theoretical concern, along with common banking practices, motivated our study. The question of whether publicly available data can indicate a systemic decline in the liquidity coverage ratio prior to the 2023 bank failures is difficult to answer. The U.S. banking system is highly heterogeneous, ranging from global institutions to smaller, local banks, which we conceptualize as savings institutions. While the banks that failed in 2023 were medium-sized by U.S. standards, for instance, the Total Assets of SVB were larger than the entire banking system of Hungary. Therefore, it is relevant to group U.S. banks by size, assuming (though not testing) that bank size correlates with the diversity of activities and the depth of their integration into both the U.S. and global economies. This size-based categorization is also important because regulation differentiates banks based on size, with the 100% LCR requirement applying only to the largest banks. Thus, compliance or non-compliance can be quantified for this group, while estimates must be used for smaller institutions. Our model, developed flexibly, enables us to estimate the LCR for banks across all groups, and partially test it using data from the largest banks.

The scope of the "affected banks" extends far beyond the four banks that the FDIC ultimately closed. The balance sheet restructuring that preceded these failures was part of a broader trend impacting nearly the entire U.S. banking system. Acharya et al. (2023) show that between 2019 and 2022, uninsured deposits increased by approximately $2,500 billion, while unrealized losses on held-to-maturity securities reached $700 billion due to the monetary tightening that began in 2022. These factors contributed to vulnerabilities at the systemic level. While targeted examinations at the regional or individual bank level could have identified those most at risk, the Federal Reserve, the FDIC, and other regulatory authorities are equipped to monitor and intervene at the individual bank level. As such, a systemic indicator test may not be necessary. However, the limitations in resources available to these authorities likely played a role in the failures observed in March 2023 (Carstens, 2023), especially as these constraints become more pronounced with the growing size and complexity of the institutions under their oversight (Coelho & Guerra, 2024). With more than 4,000 banks in the U.S., many of which are adept at concealing vulnerabilities to evade targeted supervisory scrutiny, the lack of resources and the potential for balance sheet manipulation by banks present significant challenges to identifying institutions at risk.

Our model shows how supervisory attention can be focused on a single dimension—bank size. We find that in a banking system divided into five size-based groups, the group of banks from which some ultimately failed experienced a significant decline in their LCR levels prior to the spring of 2023. Therefore, a series of inspections, even at the institutional level, focusing on this group could have potentially prevented the failures. A similar approach is employed by the International Monetary Fund (IMF) when assessing risks posed by non-systemically important banks, which are categorized by size as regional or local (Adrian et al., 2024). Their analysis shows that identifiable risks persist in the U.S. banking system even after the failures, which could help predict broader systemic instability, regardless of the size of the institutions involved.

Theoretical Background of the Liquidity Coverage Ratio

The primary objective of this study is to provide an estimate of the average Liquidity Coverage Ratio (LCR) for the U.S. banking system, for groups of banks segmented by Total Assets. Before outlining the methodology used for this estimation, we first provide a brief overview of the LCR model established by the Basel Committee on Banking Supervision (BCBS, 2013). This regulation mandates a minimum level of liquid assets that must fully cover a 30-day intensive liquidity withdrawal. While this requirement has been mandatory for all banks in the European Union since 2019, in the U.S., it only applies to banks with a Total Assets exceeding USD 250 billion. As a result, only 13 out of over 4,700 U.S. banks are subject to this regulation.

The LCR is essentially a stress test of seven items that includes the following components:

(1) Retail deposit run-off;
(2) Loss of unsecured wholesale funding;
(3) Cash outflows due to maturing repurchase agreements;
(4) Increases in margins due to deteriorating credit ratings;
(5) Higher haircuts* applied to derivative positions due to market volatility;
(6) Expected (above typical) drawdowns of committed credit lines;
(7) Repurchases of bonds and other expenditures aimed at preserving the bank's reputation.

*A "haircut" refers to the difference between the market value of an asset and the value assigned to it as collateral.

To comply with the LCR regulation, the following conditions must be met:

$$LCR = \frac{\textit{High-Quality Liquid Assets}}{\textit{Net Cash Outflows in the next 30 days}} \geq 100\%$$

The numerator consists of High-Quality Liquid Assets (HQLA), which are classified into three categories—Level 1 (L1), Level 2A (L2A), and Level 2B (L2B). The degree of liquidity in each group determines the limit up to which can be included in the calculation and level of haircuts that must be applied. The specific assets in each category are detailed in Table 1.

Table 1. The Numerator of the Liquidity Coverage Ratio*

High-quality Liquid Assets	Haircut
L1 Assets	
Cash	0%
Deposits and reservess placed at central banks	0%
Securities issued or guaranteed by the government (0% risk-weight)	0%
Government bonds (0% risk-weight)	0%
L2 Assets (Maximum 40% of HQLA stock)	
L2A Assets	
Securities issued or guaranteed by the government (20% risk-weight)	15%
Qualifying corporate bonds (rated AA- or higher)	15%
Qualifying covered bonds (rated AA- or higher)	15%
L2B Assets (Maximum 15% of HQLA stock)	
Qualifying residential mortgage-backed securities (RMBS)	25%
Qualifying corporate bonds (BBB- to A+ rating)	50%
Qualifying common equity shares	50%

The denominator is the expected net cash outflow over the next 30 days, calculated as the difference between expected cash outflows and inflows (with inflows being maximized). The components of the denominator are outlined in Table 2.

Table 2. The Denominator of the Liquidity Coverage Ratio*

Expected Cash Outflows	Multiplier
Withdrawals of Retail Deposits	
Insured deposits	3%
Uninsured deposits	10%

Expected Cash Outflows	Multiplier
Withdrawals of Unsecured Wholesale and Institutional Funds	
Withdrawals of SME deposits	
Insured deposits	5%
Uninsured deposits	10%
Interbank Operational Account Balances Withdrawals	25%
Interbank Transaction Deposits Withdrawals	25-100%
Withdrawals by Non-Financial Partners, Central Banks, and International Organizations	20-40%
Withdrawals by Other Partners' Deposits	100%
Withdrawals of Secured Funding (i.e. Repos) **	**0-100%**
Other Outflows	**0-100%**
Unexpected Drawdown of Committed Credit Lines	
Retail and SME	5%
Wholesale (credit purpose or liquidity needs)	10-30%
Institutional partners (credit purpose or liquidity needs)	40-100%
Trade finance transactions	5%
Expected Cash Inflows (Max. 75% of Cash Outflows)	**Multiplier**
Interbank Deposits	
Operating accounts	0%
Transactional accounts	100%
Maturing Secured Lending (i.e. Reverse Repos) ***	**0-100%**
Other Income from Partners	**50-100%**
Retail and Corporate Loans Maturing in the Next 30 Days	50%
Institutional Partners' Loans Maturing in the Next 30 Days	100%

* Source of tables 1 and 2: BCBS, 2013

** Depending on the type of collateral given in exchange for liquidity the expected cash outflow changes. The expected cash outflow if the collateral is an L1 asset is 0%, if an L2A asset then 15%, if an L2B asset then 25 or 50% (depending on the type of RMBS as collateral), and for every other type of collateral 100%.

*** Depending on the type of collateral accepted in exchange for liquidity the expected cash inflow changes. For L1 assets, there are no expected cash inflows, while L2A assets can be expected to generate a maximum of 15% in inflows, and L2B assets are expected to generate inflows ranging from 25% to 50%, depending on the type of collateral involved. In cases where the collateral is not of the L1, L2A, or L2B categories, 100% of the liquidity lent is expected to be repaid.

Data and modelling

The FDIC classifies U.S. banks into five groups based on Total Assets, and for the purposes of this study we use the same categorization (Table 3).

Table 3. Groups by Total Assets

	< 100M$	< 1B$	< 10B$	< 250B$	>= 250B$	Total
*Label**	*smallest*	*small*	*medium*	*large*	*largest*	
Number of Institutions	761	2,964	823	145	13	4,706
% of Total	16%	63%	17%	3%	0.30%	100%
Total Assets (B$)	46	1,098	2,277	7,091	13,087	23,6
Group Average (B$)	0.1	0.4	2.8	49	1.007	5
% of Total Assets of the Banking System	0.20%	5%	10%	30%	55%	100%
% of GDP	0%	4%	9%	28%	51%	93%

* The labels used for each group size will be referenced later in the document.
Sources: Data on banks - FDIC 2024a; data on GDP – IMF 2023

Before proceeding with the group-level estimatation of the Liquidity Coverage Ratio, we briefly outline the changes caused by the Federal Reserve's series of interest rate hikes, as reflected in the FDIC data (FDIC, 2024a).

Banks' Total Assets experienced a slight decline but remained relatively stable in size, both at the systemic level and within individual groups. Asset concentration remained high, with the 13 largest banks accounting for 55% of the Total Assets in the banking system. Despite the interest rate hikes, the size of the loan portfolio expanded, with refinanced loans rising by more than 200%. While the loan portfolio got bigger in size, its composition deteriorated: the share of delinquent and non-performing loans grew, though it remained below 1% of total loans. At both the aggregate and group levels, the deposit portfolio contracted by an average of 2.5%, with the smallest banks experiencing the largest decline (7.2%), while medium-sized banks saw a 1% increase. Additionally, the maturity composition of the deposit portfolio shifted towards higher-yielding time deposits and brokered deposits.

Interest expenses rose sharply despite the decrease in deposits, with an average increase of 226%. The largest banks saw an exceptional 459% rise in interest expenses. In contrast, interest income increased by only 33% on average, still the net interest income grew across all categories, except for the smallest banks. The largest banks recorded the most significant increase in net interest income, with a rise of 31%.

The size of the interbank loan portfolio declined sharply, with an average decrease of 24%. Stocks of available-for-sale securities fell by 25%, while held-to-maturity securities increased by 32%. The smallest banks tended to invest more in government securities and government-guaranteed instruments, whereas larger banks focused more on purchasing other kinds of domestic debt instruments. Performance indicators, such as return on assets (ROA) and return on equity (ROE), showed a slight decline across all categories, both at the systemic level and within individual groups. The proportion of unprofitable institutions increased in all categories but the largest banks, and capital adequacy ratios worsened across the banking system.

These changes align with expectations during a period of monetary tightening. Bank balance sheets contracted slightly, earnings declined, and liquidity decreased. Still, neither the aggregate nor group-level changes were significant enough to signal a looming crisis. Nevertheless we should note that the most concerning trends were the decline in interbank liquidity and the restructuring of the securities portfolio.

Data Sourcing

Though the LCR regulation is comprehensive, there is room for interpretation by local regulators or individual institutions. In this study, we estimate the LCR for the U.S. commercial banking system using publicly available quarterly reports, specifically the Bank Call Reports (FDIC 2024b and 2024c), which are collected by the FDIC. Although these reports contain over a thousand variables, their structure is not well-suited for direct LCR calculation.

Similar studies in the literature typically estimate the LCR for bank holding companies (BHC), which are required to calculate the LCR. Still, the more detailed Y9-C report filled by BHCs lacks the necessary analytical reports needed. For instance, Veeramoothoo and Hammoudeh (2022) estimate the LCR using Call Reports, but they do not specify the assumptions used. To the best of our knowledge, no comprehensive estimate for the entire U.S. commercial banking system has yet been published.

Data Cleansing

The FDIC publishes aggregated data in fifty separate tables each quarter. For our LCR estimation, we utilize 54 variables from 12 of these tables. However, the structure of the Call Reports is not directly suitable for LCR estimation. As a result, we select the variables that most closely approximate the LCR calculation items mentioned in the BCBS regulation, relying on professional judgment. Our selection is based on the approach of Ihrig et al. (2019) for estimating the stock of HQLA, as well as Nelson's (2023a, 2023b) work on estimating the LCR for Silicon Valley Bank although in most cases, we have incorporated our own considerations.

Call Reports come in two formats: a more detailed (appr. 80 page long) version for larger banks with foreign branches and a less detailed (appr. 60 page long) version for smaller banks. Approximately 80 large banks file the more detailed report, while over 4,600 banks of various sizes submit the less detailed version. Although the variables in these reports have different codes, the columns are complementary and can be coalesced. Certain items and analytics are only included in the more detailed reports; hence we use these to estimate the LCR for smaller banks as well.

Data cleansing is complicated by the inability to distinguish between zero values and non-reported data. For example, we cannot exclude observations with excessive missing data, as this may simply reflect the less complex balance sheets of smaller banks. Therefore, we remove observations with unrealistically high or low LCR estimates after the runs to ensure more accurate results.

Assumptions

As discussed earlier, despite the comprehensive nature of the LCR framework, its application to specific cases remains complex and open to interpretation. Therefore, to be able to provide an estimate of the LCR for the U.S. commercial banking system as a whole, as well as for banks grouped by size, we make the following assumptions. These assumptions use the structure of the tables seen in the previous section.

Table 4. Assumptions Used for Estimating the LCR Numerator

Asset Type	Haircut	Estimation	Remarks
L1 Assets			
Cash	0%	None	Only banks with foreign branches report stocks of cash separately; for other banks, “cash and non-interest bearing deposits” are reported. Since the amount of cash is negligible in bank balance sheets, where reported, we consider this line to be 0.
Deposits and reserves placed at central banks	0%	From Fed balance sheet + more detailed reports	The balance of central bank reserves appears only in the more detailed reports; for others, it is combined with interbank deposits. The value is estimated by subtracting the reserves of banks with foreign branches from the total “Deposits of Depository Institutions” in the Fed’s balance sheet and distributing it based on the relative size of the “Interbank and Central Bank Deposit” balance sheet line.

Asset Type	Haircut	Estimation	Remarks
Securities issued or guaranteed by the government (0% risk-weight)	0%	From more detailed reports	Government-issued or government-guaranteed mortgage-backed securities (MBS), more precisely Ginnie Mae securities, fall into this category (L1 assets). This data is reported in a separate line in the detailed reports, while in others, it is combined with the L2A Fannie Mae and Freddie Mac securities. The estimate of Ginnie Mae can be calculated by multiplying the average share of Ginnie Mae Securtities in the total MBS stock (x) from the more detailed reports with the combined line of L1 and L2A MBS line in the less detailed reports.
Government bonds (0% risk-weight)	0%	Reported value	This data is included in both types of reports.
L2A Assets (Maximum 40% of HQLA stock)			
Securities issued or guaranteed by the government (20% risk-weight)	15%	From more detailed reports	As mentioned earlier, Fannie Mae and Freddie Mac securities fall into this category. Based on the more detailed reports, for other banks the estimate is obtained by multiplying the total MBS stock by the above mentioned (1-x).
Qualifying corporate bonds (rated AA- or higher)	15%	None	Not estimated due to lack of data (specific securities and corresponding ratings are not reported).
Qualifying covered bonds (rated AA- or higher)	15%		
L2B Assets (Maximum 15% of HQLA stock)			
Qualifying residential mortgage-backed securities (RMBS)	25%	None	Not estimated, as: • it is typically considered 0 in the literature • from the 13 largest banks, only 2 report non-zero L2B holdings in their LCR reports.
Qualifying corporate bonds (BBB- to A+ rating)	50%		
Qualifying common equity shares	50%		

Table 5. Assumptions Used for Estimating the Expected Cash Outflow Items of the LCR Denominator

<table>
<tr><th rowspan="2">Expected Cash Outflow</th><th colspan="2">Outflow %</th><th rowspan="2">Selected Rows and Remarks</th></tr>
<tr><th>Regulation</th><th>Estimation</th></tr>
<tr><td>Retail Deposit run-off (insured or uninsured)</td><td>3-10%</td><td>5%</td><td>We assume that deposits under $250,000 are stable retail and SME deposits, applying a 5% withdrawal rate. (*)</td></tr>
<tr><td colspan="4">Withdrawals of Unsecured Wholesale and Institutional Funds</td></tr>
<tr><td>Withdrawals of SME Deposits (insured or uninsured)</td><td>5-10%</td><td>5%</td><td>(*)</td></tr>
<tr><td>Interbank Operational Account Balances Withdrawals</td><td>25%</td><td rowspan="4">40%</td><td rowspan="4">Since the Call Reports only show amounts below and above the deposit insurance threshold (and in foreign branches), we assume that deposits above $250,000 are wholesale deposits with a 40% withdrawal rate.</td></tr>
<tr><td>Interbank Transaction Deposits Withdrawals</td><td>25-100%</td></tr>
<tr><td>Withdrawals by Non-Financial Partners, Central Banks, and International Organizations</td><td>20-40%</td></tr>
<tr><td>Withdrawals by Other Partners' Deposits</td><td>100%</td></tr>
<tr><td colspan="4">Withdrawals of Secured Funding (i.e. Repos)</td></tr>
<tr><td>Repo with L1 Assets</td><td>0%</td><td rowspan="4">20%</td><td rowspan="4">Quarterly reports only report the size of repo transactions, not the type of securities used as collateral. Data from the 13 largest banks are used to provide a rough estimate for the banking system as a whole. Here, repo outflows as a share of total outflows varied between 2% and 43%, with a weighted average of 20%. Thus, if we estimate the other components of the cash outflow, and we multiply it by 1/(1-0.2) we get the total cash outflow.</td></tr>
<tr><td>L2A</td><td>15%</td></tr>
<tr><td>L2B (with residential mortgage-backed securities as collateral)</td><td>25-50%</td></tr>
<tr><td>Other</td><td>100%</td></tr>
<tr><td colspan="4">Other Outflows</td></tr>
<tr><td>Unexpected Drawdown of Committed Credit Lines</td><td></td><td></td><td></td></tr>
</table>

Expected Cash Outflow	Outflow %		Selected Rows and Remarks
	Regulation	Estimation	
Retail and SME	5%	5%	Includes credit cards and home equity lines of credit.
Wholesale (credit purpose or liquidity needs)	10-30%	10%	Each wholesale credit line has a specific purpose (commercial real estate, investment, agricultural, commercial, and industrial loans), so we assume a 10% drawdown rate.
Institutional partners (credit purpose or liquidity needs)	40-100%	100%	Conservatively assuming that all financial institutions draw from credit lines for liquidity purposes, we apply a 100% drawdown rate.
Trade finance transactions	0-5%	5%	This data appears in reports, so a precise estimate is given, with a conservative 5% drawdown rate assumed.

Table 6. Assumptions Used for Estimating the Expected Cash Inflow Items of the LCR Denominator

Expected Cash Inflow	Inflow %		Selected Lines and Comment
	Regulation	Estimation	
Interbank Deposits			
Operating (nostro) accounts	0%	0%	Non-interest-bearing operating accounts are not closed by banks to ensure business continuity, so they are not estimated due to the 0% withdrawal rate.
Transaction accounts	100%	100%	Interbank transactions are typically interest-bearing deposits, approximated by the balance sheet item "Interest-bearing deposits placed at other financial institutions".
Maturing Secured Lending (i.e. Reverse Repos)			
Repo with L1 Level Assets	0%	63%	As in the estimation of the cash outflows from repo transactions, we have used data from 13 of the largest banks to derive the total banking system. The share of repo inflows in total cash inflows varied between 8% and 100%, with a weighted average of 63%. Thus, if we estimated the other components of the cash inflow, multiplying them by 1/(1-0.63) we get the total cash inflow.
L2A	15%		
L2B (whether the collateral is an eligible RMBS)	25-50%		
Other	100%		
Other Income from Partners			
Maturing loans to households and corporations in the next 30 days	50%	50%	In Call Reports, banks only publish the stock of loans maturing in 3 months: dividing this by 3 gives a rough estimate of the stock maturing in 1 month. Typically, when financial institutions need liquidity, they do not apply for a loan but have another bank place a deposit at them. Based on this, we can assume that none of the loans are given to institutional partners hence the inflow rate is assumed to be uniformly 50%.
Maturing loans to institutional partners in the next 30 days	100%		

The model used to estimate the LCR was implemented using the R programming language. The code performs the necessary operations, including aggregations, applying haircuts, and other relevant calculations on the selected variables from the specified tables. After processing the data, the code removes any outlier values that are deemed erroneous, subsequently calculating group averages. The detailed results of these estimations are presented in the following section.

Results

The period under review spans from the fourth quarter of 2021, prior to the interest rate hikes, through to the first quarter of 2024. The results of the study are summarized in two ways in Figure 1. The top panel illustrates the changes in the estimated Liquidity Coverage Ratio (LCR) for each bank group on a quarter-to-quarter basis (with the dashed black line representing the 100% threshold). The bottom panel contrasts these results, allowing for easier comparison of the bank groups by size over time. Table 7 below the graph presents the numerical results.

During the period of significant interest rate hikes (Q1 2022 to Q4 2022), the LCR declined across the entire banking system and within all groups. However, it rebounded sharply by the end of Q1 2023, following the bank closures in mid-March 2023. By Q4 2022, the LCR for the banking system had fallen to 70% of its Q4 2021 value on average, but it subsequently rose to 80% of the original value by the end of Q1 2023 and is currently at 90%. The decline in liquidity across the banking system likely contributed to the bank failures, and the rebound was further supported by U.S. Treasury Secretary Janet Yellen's statement in late March 2023, in which she noted that banks were gathering liquid assets to avoid contagion (Reuters, 2023).

The most dramatic decline and rebound could be observed in banks with Total Assets between $10 billion and $250 billion, including the three banks that were closed by the FDIC. In this group, the average LCR had already fallen to 50% of the Q4 2021 level by Q3 2022, and it remained at this level through Q4 2022. However, this group experienced the fastest recovery, with the LCR increasing to 85% of the Q1 2021 value by Q1 2023, and it has remained stable since then.

Banks with Total Assets over $250 billion (the 13 banks subject to the 100% LCR requirement) maintained LCR levels close to 100%. This supports the model's validity at group level, as the actual group average LCR reported by these banks (110% ± 10%) remained relatively stable over the period according to their quarterly LCR reports.

The sharp decline in the LCR corresponds to the rapid increase in interest rates, which can be attributed to two main factors: (1) the market value of long-term assets within the liquid asset portfolio declined due to the interest rate hikes, and (2) net outflows increased as systemic liquidity needs placed pressure on individual banks. This was likely due to a rise in the share of maturing repos and a shift in depositor behaviour, as they sought higher-yielding alternatives in a rising interest rate environment.

While the results presented above are consistent with economic expectations and provide a reasonable explanation for the observed trends, they are limited by the fact that they cannot be fully verified. The literature on this topic is limited, with most studies focusing on bank holding companies and analysing periods that ended 5 to 10 years ago. Only the 13 largest banks publish actual LCR data, but their business models are so diverse that the model's general assumptions provide a good estimate at the group level rather than individual institutions.

Another limitation stems from the structure of the Call Reports. While these reports provide valuable data, they are not organized in a way that directly supports LCR calculation. Additionally, Call Reports capture a snapshot at the end of each quarter, when the risk of window dressing may be higher, whereas the LCR regulation requires quarterly average metrics.

Data cleaning also presents challenges, as it is not possible to distinguish between zero and missing values. As a result, values below 10% and above 1000%, which were flagged as erroneous estimates, were discarded ex post. These values predominantly came from the smallest banks with balance sheets of less than $100 million, which likely exhibit the lowest data quality among all groups.

Figure 1. Estimated Average LCR for Banks of Different Sizes Between Q4 2021 and Q1 2024.

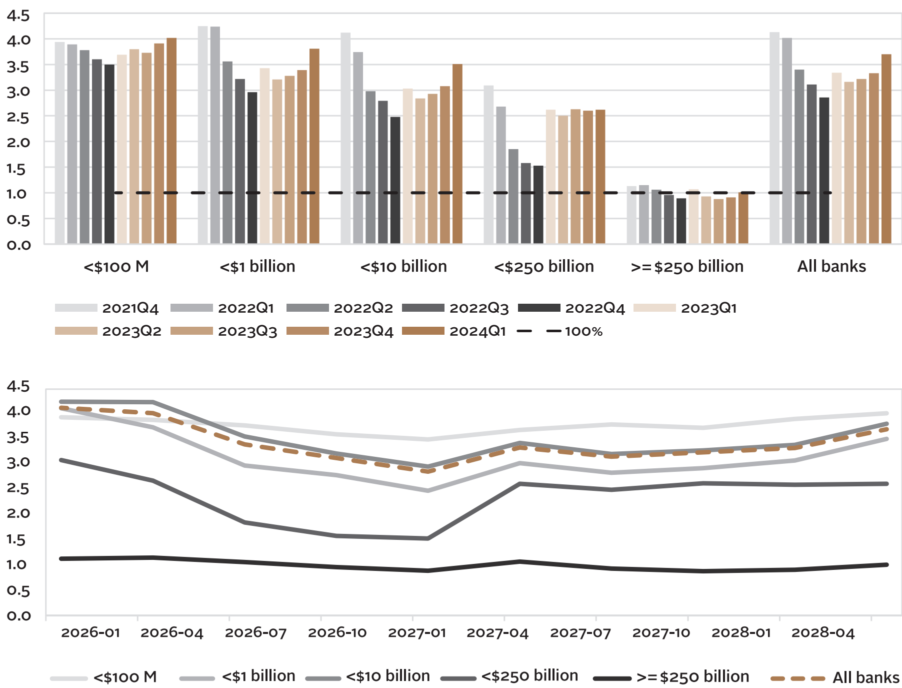

Table 7. Results of the LCR Estimation

Banking Group	21Q4	22Q1	22Q2	22Q3	22Q4	23Q1	23Q2	23Q3	23Q4	24Q1
< 100 M$	3,94	3,89	3,78	3,6	3,5	3,69	3,8	3,73	3,91	4,02
< $1 billion	4,12	3,74	2,98	2,79	2,48	3,03	2,84	2,93	3,08	3,51
< $10 billion	4,25	4,24	3,56	3,22	2,96	3,43	3,21	3,28	3,39	3,81
< $250 billion	3,09	2,68	1,85	1,58	1,53	2,62	2,5	2,63	2,6	2,62
>= $250 billion	1,13	1,15	1,06	0,96	0,89	1,07	0,93	0,88	0,91	1,01
All	4,13	4,02	3,4	3,11	2,86	3,34	3,16	3,22	3,33	3,7

Summary

In the spring of 2023, three large banks and one smaller bank in the United States ceased operations. Remarkably, two of these banks had Total Assets exceeding the size of the entire banking system of Hungary. Starting in the first quarter of 2022, the Federal Reserve began implementing significant increases to the federal funds rate—from 0.08% in February 2022 to 4.10% in December 2022, and reaching 5% in May 2023, where it has largely stabilized. These rapid and substantial rate hikes have adversely affected banks, particularly by exacerbating their liquidity risk.

In this study, we analysed the liquidity situation of the U.S. commercial banking system before the bank failures of spring 2023 and examined its status thereafter. To do so, we modelled the Liquidity Coverage Ratio (LCR), as defined by the Basel Committee on Banking Supervision. The LCR specifies a minimum level of liquid assets that should cover 100% of increased deposit outflows in the event of a systemic stress scenario.

A unique feature of the U.S. banking system is that only the 13 largest banks, out of more than 4,700, are subject to the LCR requirement, which has been mandatory in the European Union for several years. We used the quarterly Call Reports from U.S. banks for our modelling. These reports are not structured in a manner suitable for direct LCR calculation, so we made a number of assumptions and estimates based on professional judgment to develop a generalized model that could be applied at a systematic level.

The main findings of the study are as follows: during Q4 2021 (the quarter preceding the interest rate hikes) and Q4 2022 (before the bank closures), the LCR decreased at both on a systematic level and across all five groups by size of Total Assets, indicating a deterioration in the liquidity position of U.S. banks. The sharp decline coincided with a series of interest rate hikes. The group including the three closed banks experienced the most significant drop. The first two bank failures occurred in mid-March 2023, after which banks rapidly accumulated liquid assets to prevent contagion, leading to a sharp rebound in the LCR by the end of Q1 2023, across all groups and at the systemic level. Since then, the liquidity crisis has subsided, and the LCR has remained relatively stable, with a slight upward trend since Q2 2023. This recovery aligns with the slowing pace of interest rate increases and interest rate stabilization. Over the period under review, the most stable LCR values were recorded by the largest banks (with assets above $250 billion) and the smallest banks (with assets below $100 million).

The results suggest that, even using publicly available data, it is possible to estimate the LCR and identify potential liquidity problems on a group level. While it is difficult to retrospectively assess whether targeted studies of individual institutions could have prevented the failures, identifying distressed groups (by size, type, or geography) could help allocate supervisory resources more effectively and prevent banking crises.

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