Payment Risk and Bank Liquidity Management

By Ye Li and Yi Li*

Deposits constitute a dominant share of monetary aggregates and circulate as the primary means of payment in modern economies. This monetary role creates a liquidity management challenge for banks. When a depositor at one bank makes a payment to a depositor at another bank, the sending bank loses deposits on the liability side of its balance sheet and transfers reserves on the asset side to the receiving bank. As a result, depositors' payments continuously reallocate liquidity across banks.

Uncertainty in depositors' payment needs gives rise to a distinct form of liquidity risk. Driven by the underlying economic activities, depositors move funds to make payments, not out of concerns about bank solvency. Payment risk therefore differs from run risk, which has been the traditional focus of the banking literature, as well as from other forms of liquidity risk associated with financial distress. Instead, payment risk emerges from banks' day-to-day operations.[1]

Using confidential transaction-level data from Fedwire, we quantify how volatile depositors' payment flows are. For each bank and quarter, we compute the standard deviation of daily net payment outflows and scale it by the bank's beginning-of-quarter deposits or liquid assets from Call reports.[2] The frequency distributions in Figure 1 show that fluctuations in the daily payment flows can be sizable relative to the stocks of deposit liabilities and liquid assets on banks' balance sheets. In Section I, we analyze depositors' payments in greater detail and construct a bank-level measure of payment risk that captures this distinctive source of liquidity shocks.

Following the Global Financial Crisis (GFC), the U.S. banking system accumulated an unprecedented amount of liquid assets. One might expect that banks' liquidity management decisions would become largely insensitive to payment risk, as the marginal impact of payment flows would be small relative to the substantial liquidity stocks. However, this is not the case. In Section II, we show that banks' decisions to hold liquid assets did not depend on their payment risk exposure before the GFC but became rather sensitive afterward. In Section III, we offer a preliminary explanation: liquidity in the U.S. banking system has become highly concentrated among the very largest banks; meanwhile, payment volumes have grown substantially faster than liquidity for the vast majority of banks.

I. How to Measure Payment Risk

We obtain confidential data from Fedwire Funds Service (Fedwire) from 2000 to 2020. Fedwire is the real-time gross settlement (RTGS) system operated by the Federal Reserve to settle large-value payments; the system processes trillions of dollars daily. The database provides information such as the timestamp of each transaction, the identities of sender and receiver banks, payment amount, and transaction type. In Fedwire, a transfer happens between two banks either because a depositor at the sender bank makes payment to a depositor at the recipient bank ("customer-initiated transactions") or because the sender bank is actively paying the recipient bank to settle interbank debts or in exchange for assets or services. We focus on the former category.[3] These customer-initiated transactions

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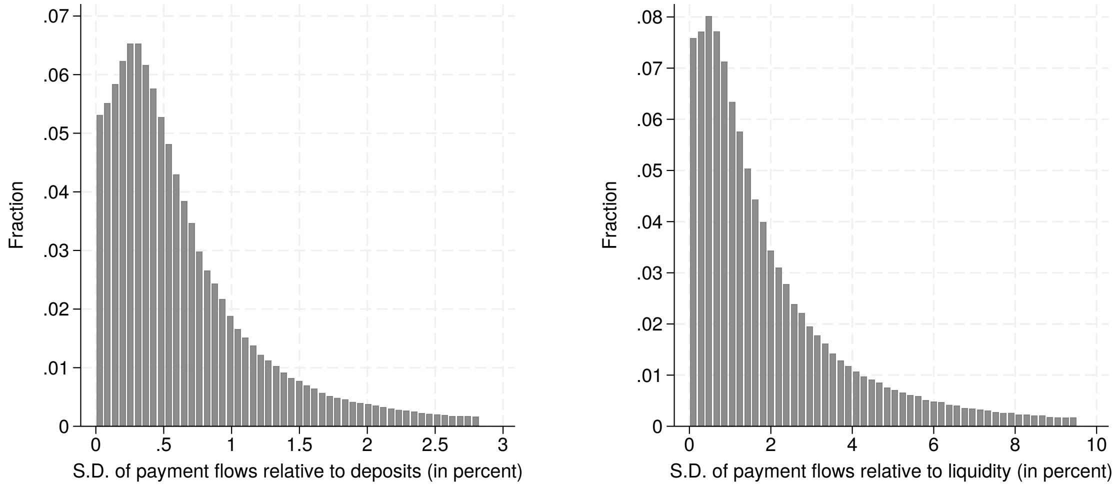
[1] Accordingly, our use of Fedwire data to characterize deposit instability differs from that of Cipriani et al. (2024) who focus on using Fedwire data to trace deposit withdrawal during the 2023 regional bank crisis.

[2] Our definition of liquid assets include banks' cash, balances due from institutions including the Federal Reserve, Federal funds sold and securities purchased under resale agreements, and available-for-trade securities.

[3] We exclude bank-initiated transfer of funds and, in particular, banks' own purchases and sales of federal funds that are relevant for prior research on interbank borrowing and lending of reserves (e.g., Furfine, 2000; Ashcraft and Duffie, 2007; Afonso et al., 2011).



(a) Payment-to-Deposits Volatility

(b) Payment-to-Liquid Assets Volatility

Figure 1. : Payment Volatility Relative to Banks' Deposits and Liquid Assets

Note: At the bank-quarter level, we compute the standard deviations of daily net payment outflows scaled by beginning-of-quarter banks' deposits (for Panel A) and liquid assets (for Panel B), respectively, and plot the frequency distributions.

account for 88% of the number of transactions. After a depositor's payment instruction, the sender bank loses deposits on the liability side and reserves on the asset side to the recipient bank. Such liquidity churn, roughly equivalent in magnitude to the U.S. GDP every two weeks, is driven by depositors' payment needs and thus out of banks' control, generating liquidity risk for banks.

During a business day (the Fedwire settlement period), a bank's payment outflows are partially offset by incoming payments as its depositors both send funds to, and receive funds from, depositors at other banks (Bech and Garratt, 2003; Afonso and Shin, 2011; Yang, 2022). As a result, banks can rely on intraday inflows to fund outgoing payments, conserving liquidity. The end-of-day payment imbalance determines a bank's liquidity gain or loss. For each day d in quarter t, we compute bank i's imbalance factor as follows:

$$Imbalance_{i,t,d} = \frac{Amount\ sent_{i,t,d} - Amount\ received_{i,t,d}}{Amount\ sent_{i,t,d} + Amount\ received_{i,t,d}} = \frac{Net\ outflow_{i,t,d}}{Gross\ volume_{i,t,d}},$$

where $Amount\ sent_{i,t,d}$ is depositors' payment outflow and $Amount\ received_{i,t,d}$ is inflow that banks i's depositors receive from other banks' depositors.

By construction, this imbalance factor takes values between -1 and 1. The net payment outflow can be decomposed: for bank i at in day d of quarter t,

$$Net\ outflow_{i,t,d} = Gross\ volume_{i,t,d} \cdot Imbalance_{i,t,d}. \tag{1}$$

A salient feature of payment dynamics is that the gross volume is highly predictable: Table 1 shows that seasonality explains gross volume with an R^2 of 91.8% for a given bank. Specifically, we regress a bank's daily gross volume (Column 1 and 2) or net outflow (Column 3 and 4) on the dummy variables for the beginning (first three business days) and the end of the month (last three business days) with bank fixed effects. This model explains well the gross volume but not the net outflow.

Therefore, the risk in $Net\ outflow_{i,t,d}$ is largely driven by the imbalance factor, and our measure of payment risk is constructed as its standard deviation: $Payment\ risk_{i,t} = s.d.(Imbalance_{i,t,d})$

Table 1—: Predictability of Gross Volume vs. Net Payment Flow

	Gross Volume (in $M)		Payment Imbalance (in $M)	
	(1)	(2)	(3)	(4)
Beginning of Month	30.77***	30.79***	0.42	0.42
	(2.85)	(2.76)	(0.17)	(0.17)
End of Month	54.64***	54.66***	-1.21	-1.21
	(3.51)	(3.40)	(-0.42)	(-0.42)
Bank FE	Yes	Yes	Yes	Yes
Quarter FE		Yes		Yes
Adjusted R^2	0.904	0.904	0.463	0.464
N of Obs.	20516835	20516835	20516835	20516835

The daily sample spans from January 2000 to December 2020 and excluding the GFC period from 2008:Q1 to 2009:Q2. The dependent variable for columns (1) and (2) is the gross payment volume for a given bank (total of payments received and sent), measured in thousands of dollars. For columns (3) and (4), the dependent variable is the net payment outflow for a given bank, also measured in thousands of dollars. $Beginning\ of\ Month$ and $End\ of\ Month$ are dummy variables for the first and last three business days of a month, respectively. Standard errors are clustered at the bank and quarter levels, with corresponding t-values in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

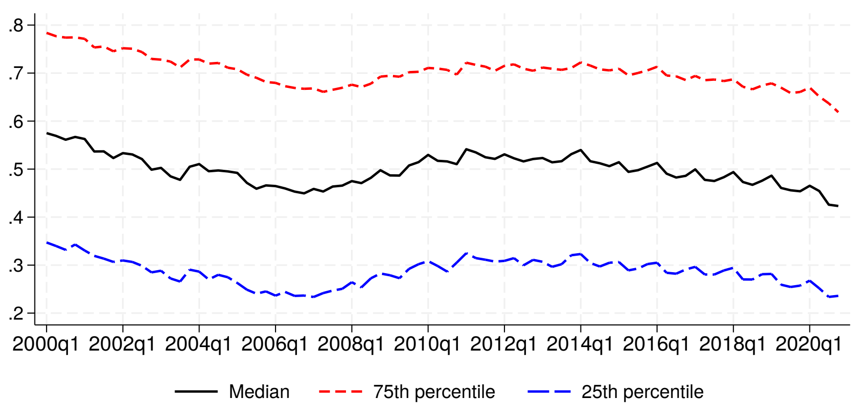


Figure 2. : The Evolution of Payment Risk Distribution

Note: This figure shows the time series of our payment risk measure in each quarter for the median bank, the bank at the 25th percentile, and the bank at the 75th percentile of payment risk. The sample period spans from 2000:Q1 to 2020:Q4.

for bank i in quarter t. In Figure 2, we plot, for each quarter, payment risk at the median, 25th percentile, and 75th percentile. The distribution shifts gradually over time but is largely stable.

Payment risk is a characteristic of depositor base that is uniquely tied to the monetary role of deposits. Our measure is scale-free, comparable across banks. It differs from traditional measures of funding instability derived from categorical assumptions—such as those used in the Basel III Net Stable Funding Ratio (for example, retail deposits are assigned 100% stability weight). And, when constructing the measure, we use only Fedwire payment records and do not involve balance-sheet items. By doing so, we avoid potential mechanical relationship and mitigate endogeneity concerns when examining the impact of payment risk on bank balance-sheet management in the next section.

II. Does Payment Risk Matter for Bank Liquidity Management

We merge Fedwire data with Call Report data to examine how payment risk affects banks' liquidity management decisions. Our quarterly sample spans from 2000:Q1 to 2020:Q4, excluding the GFC

Table 2—: Payment Risk and Bank Liquidity Holdings before and after the GFC

	Dependent variable: Liquidity Ratio$_{t+1}$					
	Full Sample		Pre-GFC		Post-GFC	
	(1)	(2)	(3)	(4)	(5)	(6)
Payment risk	0.0248***	0.0106***	0.0064	0.0029	0.0451***	0.0116***
	(4.34)	(3.02)	(1.17)	(0.97)	(5.82)	(2.79)
Capital ratio	0.3947***	0.1342***	0.4633***	0.1717***	0.3452***	0.0108
	(8.45)	(2.92)	(9.34)	(2.95)	(5.12)	(0.22)
Deposit ratio	-0.1802***	-0.0585***	-0.2160***	-0.0371***	-0.1417***	-0.0443***
	(-11.72)	(-5.93)	(-12.37)	(-3.31)	(-7.01)	(-3.68)
Return on asset	-0.8874**	-2.0894***	-1.1249**	-1.8663***	-0.5361	-1.2303***
	(-2.17)	(-8.36)	(-2.18)	(-6.08)	(-0.99)	(-6.01)
log(Size)	-0.0711***	-0.0605***	-0.0426***	-0.1153***	-0.1115***	-0.0270
	(-5.70)	(-2.90)	(-3.20)	(-3.69)	(-6.64)	(-0.91)
(log(Size))^2	0.0023***	0.0010	0.0014***	0.0032**	0.0037***	-0.0002
	(5.18)	(1.26)	(2.79)	(2.61)	(6.20)	(-0.18)
State $\times$ Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Type $\times$ Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE		Yes		Yes		Yes
Adjusted R^2	0.169	0.756	0.163	0.817	0.179	0.851
N of Obs.	327939	327752	162252	162062	165687	165560

The sample is at the bank-quarter level, spanning from 2000:Q1 to 2020:Q4, excluding the GFC period from 2008:Q1 to 2009:Q2. The dependent variable is liquidity ratio in quarter $t+1$, defined as the sum of cash, balances due from depository institutions (including those from the Federal Reserve), Federal funds sold and securities purchased under agreements to resell, and available-for-trade securities, normalized by total assets and winsorized at the top and bottom 0.5% levels. $Payment\ risk$ is the quarter-t standard deviation of a bank's daily payment imbalance factor. Control variables $Capital\ ratio$, $Deposit\ ratio$, and $Return\ on\ asset$ are as of quarter t, defined as in Table A1 and all winsorized at the top and bottom 0.5% levels. $Size$ is total assets. "State" refers to a bank's headquarter state. Bank type includes: commercial bank, thrift, and others. Standard errors are clustered at the bank and quarter levels, with corresponding t-values in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

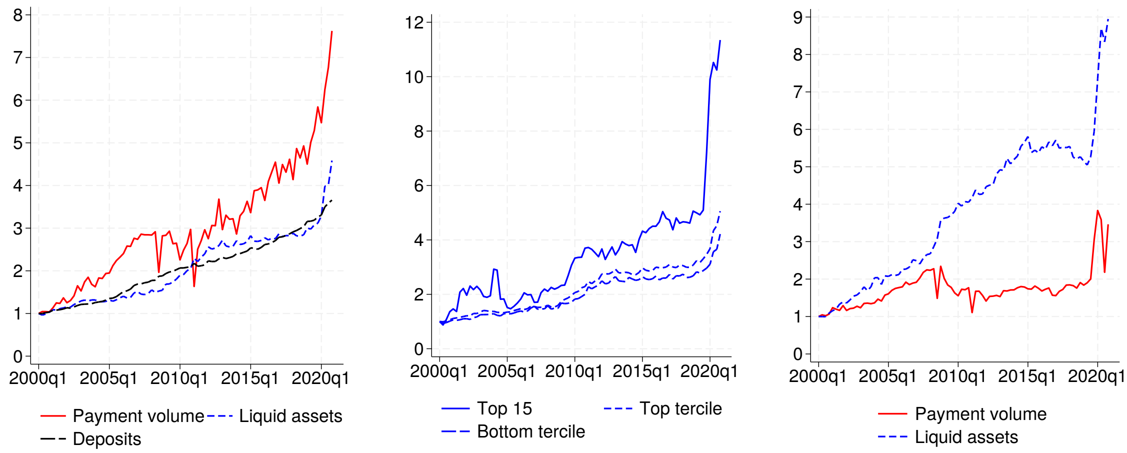
period to focus on normal times. Table A1 in the appendix reports summary statistics.

We regress the ratio of banks' liquid assets to total assets on payment risk, controlling for banks' capital-structure characteristics, such as capital-to-asset ratio and deposit-to-asset ratio, banks' profitability (return on asset), and the logarithm of size (total assets) and its squared term that accounts for potential nonlinear effects of bank size (e.g., Kishan and Opiela, 2000). We report the results from full-sample estimation, without and with bank fixed effects in Column (1) and (2) of Table 2, respectively. When facing greater payment risk, banks hold a larger fraction of assets in cash and liquid securities. The impact of payment risk is significant both statistically and economically. Column (1) shows that a one-standard-deviation increase in payment risk is associated with a 0.7-percentage-point increase in the liquidity ratio, corresponding to about 5% of its standard deviation.

What is striking is that the impact of payment risk arises entirely in the post-GFC period. In Table 2, we report the results from the pre- and post-GFC samples in Column (3)-(4) and (5)-(6), respectively. Before the GFC, banks' liquidity holding decisions do not significantly respond to payment risk. Only after the GFC, banks' sensitivity to payment risk emerges.

III. The Unbalanced Growth of Payment and Liquidity in the U.S. Banking System

Following the GFC, the U.S. banking sector accumulated a large stock of liquid assets. This may suggest that payment risk should be less of a concern in the post-GFC period, given the expansion of banks' liquidity buffers. However, such aggregate liquidity growth may not be distributed at the bank



(a) The Median of Payment, Banks' Liquid Assets, and Deposits (Indexed)

(b) Liquid Assets by Bank Deposit Size (Indexed)

(c) Average Payment Volume and Liquidity Assets of Top 15 Banks (Indexed)

Figure 3. : The Evolution of Payment Volumes, Deposits, and Bank liquidity

Note: Panel A plots the evolution of the cross-sectional medians of banks' payment volumes, liquid assets, and deposits. Panel B ranks banks in each quarter into the top 15, top tercile, and bottom tercile based on deposit levels and plots the median liquid assets for each group. Panel C includes only the top 15 banks by deposits in each quarter and plots their average payment volumes and liquid assets. All variables are indexed to their respective 2000:Q1 levels.

level proportionately in line with the growth of payment volumes.

Panel A of Figure 3 compares the growth trajectory of the median gross payment volume and that of the median liquid assets and median deposits in the cross section of banks. To facilitate comparison, we index these variables to one at the beginning of the sample period (2000:Q1). The fact that gross payment volumes have outpaced the growth of liquidity holdings implies that, after the GFC, banks face a larger challenge in managing payment risk. This pattern helps explain why banks' liquidity management decisions have become more sensitive to variation in payment risk. In addition, gross payment volumes growing faster than deposits shows an increase in bank-level money velocity.

A second defining feature of the post-GFC period is that the growth in liquid assets has been highly concentrated among the largest banks (Stulz et al., 2022). Panel B of Figure 3 compares the growth trajectories of liquid assets, indexed to one in 2000:Q1, for the top 15 banks, banks in the top tercile, and banks in the bottom tercile of the deposit distribution. The extent of liquidity concentration at the very top of the distribution is striking. Panel C further shows that, for the top 15 banks, liquid asset holdings have expanded dramatically while the growth in gross payment volumes has been much more muted throughout most of the post-GFC period.

In principle, the interbank market could redistribute liquidity ex post, allowing banks that gain liquidity through payment inflows to lend to those that experience outflows. However, the interbank market is subject to frictions (e.g., Afonso and Lagos, 2015). As a result, the ex ante distribution of liquid assets across banks plays a critical role. Our evidence shows that despite the aggregate growth of liquidity in the U.S. banking system, liquidity has not accumulated where payment risk is most pronounced. In addition, seemingly abundant reserves or ample liquidity do not necessarily imply that banks have more freely disposable liquidity or are less concerned about liquidity risk, especially under the more stringent capital and liquidity regulations introduced after the GFC. These developments have made payment risk an increasingly important determinant of banks' liquidity management and, more broadly, of their other business decisions, such as lending and deposit rates (Li and Li, 2021).

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APPENDIX

Table A1—: Summary statistics

Variable	**N**	Mean	S.D.	P25	P50	P75
Liquidity ratio	327939	0.283	0.151	0.173	0.257	0.367
Payment risk	327939	0.484	0.279	0.286	0.502	0.710
Capital ratio	327939	0.102	0.042	0.082	0.094	0.112
Deposit ratio	327939	0.604	0.130	0.524	0.609	0.696
Return on asset	327939	0.0022	0.0032	0.0014	0.0024	0.0034
Asset (in thousands)	327939	2,542,994	35,800,000	104,715	221,408	515,780

This table provides summary statistics for variables in our empirical analysis. The sample is at the bank-quarter level and spans from 2000:Q1 to 2020:Q4, excluding the GFC period from 2008:Q1 to 2009:Q2. $Asset$ is total bank assets (in thousand dollars). $Liquidity\ ratio$ is defined as the sum of cash, balances due from depository institutions (including those from the Federal Reserve), Federal funds sold and securities purchased under agreements to resell, and available-for-trade securities, scaled by $Asset$. $Payment\ risk$ is the quarterly standard deviation of a bank's daily payment imbalance factor, computed from transaction-level Fedwire data. $Capital\ ratio$ (Tier 1 capital divided by $Asset$), $Deposit\ ratio$ (non-transaction deposits divided by $Asset$), and $Return\ on\ asset$ (net income divided by $Asset$) are all winsorized at the top and bottom 0.5% levels.