Remarks by Viral V Acharya, New York University Stern School of Business Jackson Hole Symposium, 26<sup>th</sup> August 2022 – *Reassessing Constraints on Policy* 

## Liquidity Dependence

#### Why Shrinking Central Bank Balance Sheets is an Uphill Task

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w/ Rahul Chauhan, Raghuram G Rajan and Sascha Steffen

Jackson Hole, August 2022

Thank you for inviting me to speak here.

I will focus on the consequences of central bank balance sheet expansion on the liquidity claims issued by commercial banks and their effects on available systemic liquidity.

Based on joint work with Rahul Chauhan, Raghuram Rajan (Raghu is here) and Sascha Steffen, I will provide a perspective on this issue using the lens of ``liquidity dependence."

First, central bank reserves are the most liquid assets but also low-yielding, so it makes sense for the financial sector – typically banks that hold the reserves – to make money selling claims on liquidity. Raghu and I wrote a theory paper last year around this intuition, titled "Liquidity, Liquidity Everywhere, Not a Drop to Use", explaining this process and clarifying how it can lead to liquidity stress. In this paper, we try to quantify the effects empirically.

Our approach is different from the standard analysis of the transmission of quantiative easing or QE, which has focused on how changes in bank assets leads to changes in real activity. This ignores, however, the liability side of the banking sector and changes there; from a financial stability standpoint, our paper suggests this is where the key action lies.

We find that when central bank expands its balance sheet during QE, the banking sector creates short-term or demandable liabilities – on- and off-balance-sheet.

These liabilities of the banking sector do not shrink easily; therefore the withdrawal of reserves during quantitative tightening or QT leads to an asymmetric tightening of systemic liquidity conditions.

QT therefore need not be as painless as QE.

Please turn to slide 2.

## Quantitative Easing: Expansion of Fed balance sheet

Initial Balance Sheet Conditions FEDERAL RESERVE		The Fed Purchases Assets from Banks Balance Sheet Effects			
		FEDERAL RESERVE			
Assets	Liabilities	Assets	Liabilities		
Treasury securities	Reserves held by banks Cash held by the Treasury	Treasury securities +\$1	Reserves held by banks +\$1 Cash held by the Treasury	Asset swap	
BANKING SECTOR		DANKIN	with		
BANKING SECTOR		BANKING SECTOR		banks	
Assets	Liabilities	Assets	Liabilities		
Treasury securities Reserves at the Fed	Deposits	Treasury securities -\$1 Reserves at the Fed +\$1	Deposits		

Source: "How the Fed Changes the Size of its Balance Sheet" (Leonard, Martin and Potter, Liberty Street Economics, 2017)

To put us on common ground, let me walk through the process via which a central bank such as the Fed expands its balance-sheet.

The Fed swaps assets such as Treasury or Agency-backed securities for reserves.

Typically, the reserves end up on commercial bank balance-sheets.

The asset swap, however, may happen in two ways.

One, the asset swap can happen directly with banks as shown on slide 2.

In this case, banks swap eligible securities for reserves, and the process of Fed injecting reserves directly does not lead to a growth of bank deposits.

#### Slide 3

### Quantitative Easing: Expansion of Fed balance sheet

Initial Balance Sheet Conditions				The Fed Purchases Assets from the Public Balance Sheet Effects				
FEDERAL RESERVE			FEDERAL RESERVE		Expansion			
-				Assets	Liabilities			
Treasury securities	Reserves held by banks			Treasury securities +\$1	Reserves held by banks +\$1	financed with bank		
	Cash held by the Treasury				Cash held by the Treasury	dep	oosits	
BANKING SECTOR PUBLIC		BANKING SECTOR		PUBLIC				
Assets	Liabilities	Assets	Liabilities	Assets	Liabilities	Assets	Liskilities	
Treasury securities Reserves at the Fed	Deposits	Deposits Treasury securities	Wealth	Treasury securities Reserves at the Fed +\$1	Deposits +\$1	Deposits +\$1 Treasury securities -\$1	Wealth	

Source: "How the Fed Changes the Size of its Balance Sheet" (Leonard, Martin and Potter, Liberty Street Economics, 2017)

Second, as shown on slide 3, the non-bank sector (say the public) can also sell eligible assets to the Fed. The payment is deposited in commercial banks; banks add reserves to their assets and these are effectively "financed" by the deposits of the non-bank sector that sold the asset. Without any indirect or multiplier effects via the bank balance-sheets, there is a one for one expansion of banking sector balance-sheet with reserves. Importantly, its deposits, which typically will be wholesale demandable deposits, expand with reserves. Given these different ways that Fed expansion of balance-sheet affects the banking sector, the following questions arise:

How does Fed balance-sheet expansion affect the size and demandable deposit base of the banking sector?

Do other demandable liabilities issued by banks such as credit lines to corporations also grow with reserves?

If banking sector liabilities grow, do they reverse via the same mechanism when the Fed shrinks its balance-sheet?

Let us turn to the evidence with results summarized on slide 4.

# In Practice: Quantitative Tightening (QT) is not simply a reversal of Easing (QE).

- We find QE is associated with a growth of on- and off-balance-sheet demandable bank liabilities
  - Demand deposits expand with aggregate reserves - Akin to asset purchases from non-banks in QE
  - Plus shrinkage of deposit maturity; additional writing of credit lines
- However, QT is NOT associated with a shrinkage of these liquidity claims
  - Demand deposits and credit lines continue to grow post-QE and during QT
- In effect, QE creates "liquidity dependence" in the banking system
- Undertaking QT can be an uphill task given this liquidity dependence
  - Potentially explains why system seems fragile to liquidity disruptions
  - Repo spike of September 2019, "dash for cash" during March 2020

First, we find that quantitative easing, i.e., an increase in aggregate reserves, is indeed associated with a growth of bank deposits. This is consistent with asset purchases by the Fed being in large part from non-banks. The rise in bank deposits is primarily in demandable deposits; time deposits in fact shrink during QE. In addition, banks originate more credit lines for corporations. The financing with demand deposits, the reduction in time deposits, and the writing of off-balance-sheet claims suggest an active response by banks to write demandable claims when aggregate reserves increase.

Second, and our most important result, is that quantitative tightening is NOT simply a reversal of quantitative easing – when Fed shrinks aggregate reserves. Demand deposits and credit lines continue to grow even after QE is over; they stabilize eventually, but do not shrink much – if at all – even during QT.

We refer to this phenomenon – whereby QE leaves the banking system with more on- and offbalance-sheet demandable claims that are not simply reversed with QT – as "liquidity dependence", since it necessitates even greater central bank balance sheet support in the future. Liquidity dependence can also explain why the financial system suffered from liquidity stress in the form of the repo spike of Sept 2019 and the "dash for cash" during COVID outbreak of March

2020 - in spite of reserves being in excess of \$1 trillion.

To help understand this and also how QT might play out in future, I will show you next what was the level of demandable claims of the banking system at these points of time.

Turn to slide 5 for Figure 1.1.





## 1.1 Reserves and Claims (fraction of GDP)

The blue line is reserves, the red line is outstanding bank credit lines (both on the left axis) and green line is bank deposits (on the right axis), all relative to GDP.

The vertical lines correspond to the beginning of the different QE and QT programs of the Fed: Nov 2008 for QE I, Nov 2010 for QE II, Nov 2012 for QE III, Oct 2014 when QE was halted without actively reducing balance sheet size, October 2017 for QT or active balance sheet reduction, and Sept 2019 for the repo-market "spike" and liquidity infusion followed by Pandemicinduced QE in March 2020 (which we collectively refer to as "Pandemic QE").

Key patterns that emerge are as follows:

Reserves expanded from the start of QE I to the end of QE III from 5% of GDP to 15% of GDP. There is some stabilization, even decline, in reserves when each phase of QE ended and before the next phase began. At the same time, as reserves expanded, bank deposits grew from 50% to 60% of GDP, again with some stabilization when each phase of QE ended and before the next one began.

While the increase in credit lines was less pronounced at first, they too increased from the start of QE II from 12% to 15% of GDP by Sep 2014.

Importantly, while reserves dropped by more than half after QE was halted and until September 2019 when QE resumed, both credit lines and deposits remained remarkably flat; in particular, they did not simply reverse their increase during QE I-III.

However, when reserves increased from 7% to 17% of GDP during the pandemic QE, bank deposits jumped again from 60% to 80% of GDP and credit lines also increased to 17% of GDP. This descriptive evidence already highlights the asymmetric effect of an expansion vis-à-vis shrinkage of the Fed balance sheet on commercial bank demandable claims.

Now turn to slide 6 for Figure 1.2 to see this point more sharply.



1.2 Claims on Liquidity (multiple of reserves)

From a financial stability standpoint, it is interesting to ask how large deposits and outstanding credit lines are relative to aggregate reserves, i.e., the Fed balance-sheet size.

In Figure 1.2, blue line is outstanding bank credit lines (on the left y-axis) and red line is bank deposits (on the right y-axis), both relative to reserves.

At the beginning of QE I-III as well as the pandemic QE, credit lines and deposits drop as a multiple of reserves.

In contrast, when the Fed started normalizing and shrinking its balance-sheet size after October 2014, both credit lines and deposits more than doubled relative to reserves.

Even more interestingly, by Sep 2019, the ratios are almost at the same level for both deposits and credit lines as in 2008 before QE began.

In other words, a shrinkage of the Fed balance-sheet during QT by a magnitude far smaller than the expansion undertaken during QE led to the claims on liquidity relative to available reserves reaching pre-QE levels. Put differently, far more reserves were now needed to back the liquidity claims that had been written.

Let me now turn to the maturity of outstanding deposits on slide 7, Figure 1.3.





## 1.3 Demand and Time Deposits (% of GDP)

The blue line is time deposits (CDs), the red line is demand deposits (checking, savings, moneymarket savings), and green line is aggregate reserves, all relative to GDP.

We see that time deposits shrink substantially during QE, stabilize some during post-QE and even rise during QT, whereas demand deposits rise more than one for one during QE, keep growing post-QE, and come down only marginally during QT.

We find that these effects are driven almost entirely by the uninsured portion of deposits, which tends to be more demandable than insured deposits.

The maturity-shortening of bank deposits is thus another dimension of liquidity dependence induced by QE.

Lopez-Salido and Vissing-Jorgensen (2022) offer another way of seeing this. They focus on the price of liquidity, measured as Effective Fed Funds Rate minus the Interest on Reserves (EFFR-IOR), which is plotted on the y-axis in Figure 2 on the next slide #8.

Slide 8



#### 2. What explains the price of liquidity?

Note: inspired by Lopez-Salido and Vissing-Jorgensen (2022)

In the left plot, x-axis is the log of aggregate reserves. As they show, and we replicate here, the price of liquidity seems unrelated to the quantity of reserves directly.

Lopez-Salido and Vissing-Jorgensen then show that to get any sensible pricing of liquidity, we need to add the "demand" for reserves, i.e., bank deposits, as another explanatory variable in the regression of EFFR-IOR on reserves. We argue that credit lines too can serve as a proxy for the demand for reserves instead of deposits. Of course, including both does the best job, and we show the consequences on the right, where we plot the relation between EFFR-IOR and the reserves after adjusting for bank deposits and credit lines. [TYPO: The x-axis label should read as "adjusted reserves", not "spread".]

In more detailed work, we find the effect of demandable deposits is about three times as large as that of time deposits, confirming that what influences the price of liquidity are claims on reserves that can be exercised with immediacy.

Are these effects robust econometrically?

We verify this by examining the cross-section of banks over time. This requires that we instrument reserves at the individual bank level but it provides for better causal inference; panel data also provide statistical power to verify patterns within individual QE/QT episodes.

A brief summary of what we find in panel tests is on the next slide #9.

#### **Econometric Results**

• Time-series:

1. and 2. confirmed in time-series analysis

- However, limited statistical power to draw causal inference during specific QE/QT periods

Panel I:

- Mirror time-series quantity results with instrumented reserves

- 3. Reserves → Demandable Deposits ↑ in QE, but no reversal of claims in post-QE / QT
- 4. Reserves → Credit lines to IG + non-rated firms ↑ in QE, but no reversal in post-QE / QT

• Panel II:

- Mirror time-series results on the price of liquidity (also instrument deposits)

5. Reserves → Term spread of deposits ↓ [ 3m/18m/24m CD rate - Savings rate ]

6. Reserves → All-in-spread drawn/ spread undrawn of LCs to IG + non-rated firms ↓

- Again, effects during QE, but no reversal in post-QE / QT

Focusing on quantity results as to how reserves affect demandable claims, we confirm that an exogenous increase in a bank's reserves increases its deposits, in particular, its demandable deposits, while shrinking its time deposits; and also increases the origination of credit lines. Both of these results hold for QE, but there is no reversal post-QE or in QT.

Turning to the price of liquidity for individual banks, we rely on two other bank-level measures:

- The spread in deposit rates between term deposits of different maturities and the savings deposit rate; a compression of this spread implies the bank prefers shorter maturity deposits.
- All-in-drawn spread in credit lines scaled by undrawn spread; a lowering of this ratio indicates a bank preference to supply immediacy by selling claims on reserves.

Because we can analyze panels at different time periods, we can also highlight the asymmetry between QE and post-QE/QT for individual banks.

#### Slide 9

For instance, the table on the next slide #10 shows the second-stage of the IV analysis for the determinant of bank spreads, instrumenting both deposits and reserves.

#### Slide 10

## (Panel) Reserves -> Lower deposit term spreads

Panel B: IV	(1)	(2)	(3)	(4)	
	3 month CD	12 month CD	18 month CD	24 month CD	
	Rate - Savings	Rate - Savings	Rate - Savings	Rate - Savings	Bar
	Rate	Rate	Rate	Rate	prefer
Ln(Total Deposits)	0.179	0.330*	0.496*	$0.400^{**}$	to sho
	(0.178)	(0.177)	(0.253)	(0.169)	to sho
					the mat
Ln(Reserves)	-0.109***	-0.0502	-0.220***	-0.111****	of dep
	(0.0304)	(0.0528)	(0.0558)	(0.0282)	in O
Obs	85319	91212	76421	89830	
Bank & Time-FE	Y	Y	Y	Y	No rev
Bank and Time	Y	Y	Y	Y	of th
Clustered SEs					prefere
Reg Type	IV	IV	IV	IV	
Period	Overall:	Overall:	Overall:	Overall:	-post-QE
	2001Q1 -	2001Q1 -	2001Q1 -	2001Q1 -	
	2021Q4	2021Q4	2021Q4	2021Q4	

We find that an increase in a bank's reserves lowers its offered term-spread between CDs and savings rates, implying a preference for shortening the duration of deposits when it exogenously ends up with more reserves such as during QE.

Let me then recap with the next two slides and offer some policy implications.



Slide 11

• As demand is exogenous, increasing supply of reserves is stabilizing

Slide #11 represents the wrong way to think about QE: taking the nature of claims on liquidity on the banking sector as given and unaffected by reserve expansion.

Under this view, an increase in central bank b/s size always lowers the price of liquidity and improves financial stability, so that a solution to any liquidity stress is to inject even more reserves.

#### Slide 12

#### Dependence view: Liquidity demand affected by reserves



· Supply of reserves creates its own additional demand, new claims written by banks.

• Liquidity conditions and the effect of quantitative tightening depend on how these claims evolve.

In contrast, our liquidity dependence view on slide #12 suggests that banks write new liquidity claims when exogenously pumped full of reserves, and don't shrink these claims easily. The supply of reserves creates its own additional demand via these new claims that can come due

in times of aggregate stress.

This implies reserve expansion may have muted, even adverse, effects on available liquidity and thence financial stability, with maximum danger when reserves are shrunk.

Notably, the pandemic QE has caused banking sector demandable liabilities to rise again... and the Fed has embarked on QT.

The past suggests no guarantee that these liabilities will shrink as the Fed shrinks its balance-sheet.

What then are some of the other policy implications? Let me stress the most important ones:

- Liquidity dependence can create a potential conflict with the Fed's monetary policy objectives when QT is embarked upon. To shrink aggregate demand, the Fed may want to tighten monetary conditions; however, demandable liabilities in the banking system can create financial stability issues, preventing the Fed from unwinding stimulus at a pace commensurate with monetary objectives.
- As QT is embarked upon, careful attention will have to be paid to the system's demandable claims and to ensuring the mobility of reserves within the banking system.
- On the former, banks can be incentivized to hold more time deposits rather than demandable ones and capital charges for undrawn credit lines can be raised.
- On the latter, Liquidity Coverage Ratio and Resolution Planning liquidity requirements for banks can be required to be met on a fortnightly basis with some tolerance allowed on a daily basis; this can create incentives for banks to not hoard reserves by reducing the supervisory stigma of temporarily falling short.
- Next, the Fed can reduce the flow of reserves through commercial bank balance sheets by placing them directly with non-banks via Reverse Repo facilities.
- However, since most of the reserves will be held by the banking sector, which will issue hard-to-reverse liquidity claims on them, the scale, scope and duration of QE may have to be rethought, especially when QE is simply "pushing along a string".
- Equally importantly, liquidity dependence warrants that the Fed proceed on QT carefully while closely monitoring outstanding liquidity claims.

#### Appendix:

Billion USD			
	Reserves	Demand Deposits Credit Lines	
	821	4,887	2,015
December 2008			
	1,505	11,762	3,269
June 2019			
	1,698	12,129	3,330
December 2019			
	2,099	12,730	3,068
March 2020			
	3,135	15,844	3,577
December 2020			
	4,188	18,374	3,880
December 2021			