Liquidity, liquidity everywhere, not a drop to use

Why flooding banks with central bank reserves may not expand liquidity

- Viral V Acharya (NYU Stern) and Raghuram G Rajan (Chicago Booth)

November 2021
Motivation
Where did all the liquidity go?

• Unprecedented expansion of central bank balance sheets since the GFC
  - “flooding banks with central bank reserves”

• Effects on economic activity modest, evidence mixed on the working of unconventional channels (such as “portfolio balance”)
  - Fabo, Jancokova, Kempf, and Pastor (2021), Diamond, Jiang, and Ma (2021)

• Surprisingly fragile liquidity conditions in money markets
  - Unexpectedly large spikes in repo markets in September 2019:
    - Encumbrances on liquidity, exogenous shrinkage, unwinding of levered trades in Treasuries
  - Dash for cash in March 2020:
    - Corporate credit line drawdowns on banks, lack of adequate market-making

• Liquidity, liquidity everywhere -> Yet bigger liquidity injections in future?
  - Does the ex-ante supply of reserves affect the ex-post demand for them?
  - Liquidity dependence
Traditional view: Exogenous demand for liquidity

Price of Liquidity in Stress =

Exogenous demand for liquidity

• As demand is exogenous, increasing supply of reserves is stabilizing
Liquidity dependence is endogenous to reserves

Price of Liquidity in Stress = \[ \text{Supply of Reserves} \] vs. \[ \text{Liquidity claims against Reserves} \]

- Supply of reserves creates its own demand, which can destabilize
Three important considerations

I. *Ex ante*: How are the reserves financed?

- When reserves are injected via asset purchases from non-banks, they typically deposit reserves in banks
- Do banks rebalance these deposits with new capital issuances, or are reserves financed with deposits (and deposit-like) claims?
  - Reserves may also be swapped directly against bank assets; as reserves are short-term in nature, do banks maturity-match their liability structure with more deposits?
  - Or do they readjust liabilities toward the longer term?
- The way reserves are financed matters as demand deposits will be a claim on reserves in future
Some evidence on the financing of reserves

**QE III** (between September 2012 and October 2014)  

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
<th>In million $</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash</td>
<td>Bonds</td>
<td>-112,030</td>
</tr>
<tr>
<td>Debt Securities</td>
<td>Holding company investment</td>
<td>332,381</td>
</tr>
<tr>
<td>Loans</td>
<td>Commercial paper</td>
<td>-86,743</td>
</tr>
<tr>
<td>misc</td>
<td>Loans</td>
<td>108,019</td>
</tr>
<tr>
<td>Repos</td>
<td>Miscellaneous</td>
<td>184,540</td>
</tr>
<tr>
<td><strong>Reserves</strong></td>
<td>Insured deposits</td>
<td>-810,496</td>
</tr>
<tr>
<td></td>
<td>Uninsured deposits</td>
<td>2,528,429</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>2,144,100</strong></td>
</tr>
<tr>
<td></td>
<td>Deposits/Total Liabilities</td>
<td>0.80124</td>
</tr>
<tr>
<td></td>
<td>Deposits/(Cash+Securities+ Repos+ Reserves)</td>
<td>1.43187</td>
</tr>
<tr>
<td></td>
<td>Deposits/(Repos+Reserves)</td>
<td>2.51177</td>
</tr>
<tr>
<td></td>
<td>Uninsured deposits/(Repos+ Reserves)</td>
<td>3.69679</td>
</tr>
<tr>
<td></td>
<td>Uninsured deposits/(Uninsured+ insured deposits)</td>
<td>1.47179</td>
</tr>
</tbody>
</table>

Change / Change
Some evidence...

**Pandemic (between March 2020 to end 2020)**  
**In million $**

<table>
<thead>
<tr>
<th>Assets</th>
<th></th>
<th>Liabilities</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash</td>
<td>15,843</td>
<td>Bonds</td>
<td>26,083</td>
</tr>
<tr>
<td>Debt Securities</td>
<td>1,041,056</td>
<td>Holding company investment</td>
<td>202,606</td>
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<tr>
<td>Loans</td>
<td>289,404</td>
<td>Commercial paper</td>
<td>26,651</td>
</tr>
<tr>
<td>misc</td>
<td>272,661</td>
<td>Loans</td>
<td>-227,272</td>
</tr>
<tr>
<td>Repos</td>
<td>179,821</td>
<td>Miscellaneous</td>
<td>-125,790</td>
</tr>
<tr>
<td><strong>Reserves</strong></td>
<td>1,282,417</td>
<td>Insured deposits</td>
<td>1,317,938</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Uninsured deposits</td>
<td>1,719,650</td>
</tr>
<tr>
<td></td>
<td><strong>3,081,202</strong></td>
<td></td>
<td><strong>2,939,866</strong></td>
</tr>
</tbody>
</table>

Deposits/Total Liabilities 1.03324  
Deposits/(Cash+Securities+ Repos+ Reserves) 1.20581  
Deposits/(Repos+Reserves) 2.07736  
Uninsured deposits/(Repos+ Reserves) 1.17604  
Uninsured deposits/(Uninsured+ insured deposits) 0.56612
Three important considerations

II. *Ex post*: Are the reserves free to move around to meet claims?
- Unused liquid reserves are a drain on bank profits – typically their liquidity services are sold so they are “fully” utilized.
  - Yankov (2020): LCR announcement in 2010 and implementation starting 2014 coincident with increase in bank credit line provision to shadow banks
- Speculation: Conditions under which reserves are created may spur risk-taking and the associated need for margins, central clearing guarantee funds, etc., all provided by commercial banks.
  - Barth and Kahn (2021): Build-up of leveraged Treasury positions during 2013 ($200 bln) to 2019 ($800 bln), with a blow-up in March 2020
- Regulation: liquidity requirements “lock up” reserves in stress scenarios (Diamond and Kashyap, 2016; Vandeweyer, 2019; others)
- Ratcheting: reserve holdings creates its own supervisory demand (Nelson, 2019)
Three important considerations

III. *Ex post*: Will banks with free reserves lend them out?

- Fear of “taint” in surplus banks

- Receive flight-to-safety deposits passively, rather than lend out reserves in inter-bank markets actively
  - Acharya and Mora (2015): Only stressed banks sought to raise deposits actively
  - Copeland, Duffie and Yang (2021): High-reserve balance banks delayed inter-bank payments

- Effectively, there can be a “convenience yield” on reserves during times of stress

- Liquidity hoarding: Only some surplus banks will lend and become “tainted”, while others will hoard reserves, be seen as safe, and get “flight-to-safety” deposits.
Our primary insight

• When liquidity stress materializes the apparent comfort provided by a high level of reserves vanishes
  - Deposits issued to finance reserves demand liquidity (“dash for cash”)
  - Part of the reserves remain encumbered by speculation/for regulatory purposes
  - Surplus banks may prefer to hoard liquidity to benefit from flight to safety
• Ordinarily, this will mean there is far less spare liquidity than suggested by the simple reserve expansion
• In *extremis*, the higher the reserves issued ex ante, more fragile the money markets and higher the inter-bank rates in stress
  - Adverse real consequences on investments (ex post as well as ex ante)
Does this matter? Yes, alters policy prescriptions

• Seeing ex post stress, some economists recommend
  • More central bank balance-sheet expansion (Copeland, Duffie and Yang, 2021)
  • Lower ex-ante capital requirements, especially against reserves (Liang and Parkinson, 2020)

• What seems sensible ex post could aggravate the problem when seen from an ex-ante perspective.

• Reserve issuance may not crowd out private deposit-like claims, may in fact enhance it, as the evidence shows.
  - Contrast with Stein (2012); Greenwood, Hanson and Stein (2015), (2016).

• Limiting central bank balance-sheet size ("reversal size") may be an important part of prudent management of financial fragility risks.
Model

Firms, Banks, Investors, ... Money markets to shuffle around liquidity
Firms, Banks, Depositors, Investors

• Banks and firms “regionally” or “sectorally” matched
• Firms and banks owners are risk-neutral, expected profit-maximizers
• Firms:
  - Invest at date 0 to obtain returns at date 2, funded by
    ➢ Firm owners’ initial wealth
    ➢ Term loans from banks
  - Place deposits with bank (equivalent to committed line of credit, net of fees)
Firms, Banks, Depositors, Investors

- Banks at date 0:
  - Assets
    - Illiquid term loan to their firm/sector
    - Liquid reserves that “shrink/are encumbered” at date 1 (τ, exogenous for now...)
  - Liabilities I: (Unlimited) Uninsured deposits from risk-averse investors at date 0
    - Log-utility investors as in Stein (2012)
  - Liabilities II: (Limited) capital from deep-pocket risk-neutral investors with due-diligence costs
    - Deadweight costs of capital issuance: $\frac{\alpha_i}{2} e_i^2$ at date t due to due diligence, agency, market power, illiquidity
Liquidity stress in the economy

• State of the economy \( (y) \) at date 1
  - Economic stress occurs with probability \( q / \theta \), healthy otherwise.

• State of each bank-firm pair \( (z) \)
  - Conditional on economy stress, investment has to be rescued probability \( \theta \)
  - Unconditionally, w.p. \( q \)
  - Rescue investment at date 1 with probability \( q \), funded by
    - Firm withdrawing its bank deposit
    - Firm borrowing from its bank (or any other bank) in spot bank loan market
  - Rescue investment repays high return in expectation, making up for loss on initial investment
  - But... non-zero probability of no return (Stein 2012)
Banks at date 1

• y and z once resolved are common knowledge to all agents

• If bank-firm pair stressed
  • Risk averse depositors will run.
    ➢ If they anticipate default at date 2 -> Run at date 1 in case of stress even when the bank is solvent
    ➢ Runs -> Flight to safety of deposits and rescue loans to “untainted” healthy banks

• Firm will withdraw deposit and ask for additional loan upto the size of its date-1 “rescue” investment.
Bank funding at date 1

• Stressed banks will raise funding
  (1) From the inter-bank market.
  (2) They also can raise date-1 capital from Warren Buffet.

• Only a fraction $\varphi$ of healthy banks lend to stressed banks in the inter-bank
  - Fear of being “tainted” if reserve balances are low; exogenous, but endogenized later

• Remaining $1 - \varphi$ healthy banks receive flight-to-safety deposits.
Healthy Economy (y=0)

1 - \frac{q}{\theta}

\frac{q}{\theta}

Liquidity stressed Economy (y=1)

\frac{q}{\theta}

\frac{q}{\theta}

\frac{q}{\theta}

Healthy firm (z=0)

1

Fraction

1 - \varphi

\theta

Fraction

\varphi

Stressed Firm, Rescue Investment (z=1)

Safe Bank (y.z=0)

Liquidity Hoarding

Tainted Bank (y.z=0)

Inter-bank market

Stressed Bank (y.z=1)

Flight To Safety

Bank-firm pairs, date-0 investment

Date 0

Date 1
Firms, Banks, Depositors, Investors

• Interest rates

  - Common discount rate is zero throughout, but ...

  - Spot bank loans at date 1 to firms charge $1 + r_i + \gamma$
    - $r_i$ is the marginal cost of bank funding (via capital issuance or inter-bank borrowing)
    - $\gamma$ is the premium bank charges for monitoring costs in stress scenario

• Date-1 capital issuances transfer reserves from “safe” banks
  - Other assumptions would raise date-1 money-market rate even higher
### Firm Balance Sheet at Date 0

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_0$</td>
<td>$L_0^F$</td>
</tr>
<tr>
<td>$D_0^F$</td>
<td>$W_0^F$</td>
</tr>
<tr>
<td></td>
<td>Net worth</td>
</tr>
</tbody>
</table>

### Bank Balance Sheet at Date 0

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>$L_0^B + \frac{1}{2} \lambda (L_0^B)^2$</td>
<td>$D_0$</td>
</tr>
<tr>
<td>$S_0$</td>
<td>$e_0$</td>
</tr>
<tr>
<td></td>
<td>Net worth</td>
</tr>
</tbody>
</table>

### Firm Balance Sheet at Date 1 if stressed

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_1$</td>
<td>$I_1^F$</td>
</tr>
<tr>
<td>$L_0^B$</td>
<td>$L_0^F$</td>
</tr>
<tr>
<td></td>
<td>Net worth</td>
</tr>
</tbody>
</table>

### Bank Balance Sheet at Date 1 if bank stressed

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>$L_0^B + \frac{1}{2} \lambda (L_0^B)^2$</td>
<td>Possible interbank borrowing = $b_1$</td>
</tr>
<tr>
<td>$\tau S_0$</td>
<td>$e_1$</td>
</tr>
<tr>
<td></td>
<td>$e_0$</td>
</tr>
<tr>
<td>$I_1^B$ ($= I_1^F$)</td>
<td>Net worth</td>
</tr>
</tbody>
</table>

- Will run to “safe” banks if stressed
- Rescue investment, Redeposited in “safe” banks
- Encumbrance on reserves
- Liquidity Demand at date 1
<table>
<thead>
<tr>
<th>Firm Balance Sheet at Date 0</th>
<th>Bank Balance Sheet at Date 0</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Assets</strong></td>
<td><strong>Assets</strong></td>
</tr>
<tr>
<td>$I_0$</td>
<td>$L_0^B + \frac{1}{2} \lambda (L_0^B)^2$</td>
</tr>
<tr>
<td>$D_0^F$</td>
<td>$D_0$</td>
</tr>
<tr>
<td><strong>Liabilities</strong></td>
<td><strong>Liabilities</strong></td>
</tr>
<tr>
<td>$L_0^F$</td>
<td>$\frac{1}{2} \lambda (L_0^B)^2$</td>
</tr>
<tr>
<td>$W_0^F$</td>
<td>$e_0$</td>
</tr>
<tr>
<td>Net worth</td>
<td>Net worth</td>
</tr>
</tbody>
</table>

**Firm Balance Sheet at Date 1 if healthy**

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_0$</td>
<td>$L_0^F$</td>
</tr>
<tr>
<td>$D_0^F$</td>
<td>$W_0^F$</td>
</tr>
<tr>
<td></td>
<td>Net worth</td>
</tr>
</tbody>
</table>

**Bank Balance Sheet at Date 1 if bank healthy, economy stressed**

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>$L_0^B$</td>
<td>$D_0$</td>
</tr>
<tr>
<td></td>
<td>$e_1$</td>
</tr>
</tbody>
</table>

Interbank loans of up to $e_1 + (1-\tau)S_0$

Reserves of $(S_0 + e_1$-interbank loans)

“Tainted” Bank

**Liquidity Supply**

**Shrinkage of reserves**
Firm’s problem

• Date 0:

\[
\text{Max}_{l_0^E, D_0^E} \left( (1-\gamma) \left[ g_0(I_0) + D_0^F \right] + q \left[ g_1(I_1) - l_1^E \left( 1 + \gamma + r_1 \right) \right] - R_0^L L_0^E \right)
\]

• Date 1:

\[
\text{Max}_{l_1} \left[ g_1(I_1) - l_1^E \left( 1 + \gamma + r_1 \right) \right]
\]

• Budget constraints:

\[
\text{s.t. } I_0 = L_0^E + W_0^F - D_0^E \quad \text{and} \quad I_1 = l_1^E + D_0^F
\]
Bank’s problem

\[
\text{Max}_{\ell_0^B, e_0, e_1} \quad R_0^L L_0^B + S_0 - e_0 - \frac{\alpha_0}{2} e_0^2 - D_0 \\
+ \frac{q}{\theta} \left[ -e_1 - \frac{\alpha_1}{2} (e_1)^2 - (1 + r_1) \left( b_1(y = 1, z = 1) - l_1^B \right) \right] \\
+ \frac{q}{\theta} (1 - \theta) \varphi \left[ -e_1 - \frac{\alpha_1}{2} (e_1)^2 + (1 + r_i) b_1(y = 1, z = 0) \right]
\]

s.t. \( D_0 + e_0 = L_0^B + \frac{1}{2} \lambda (L_0^B)^2 + S_0 \)

Deposits are decided residually based on capital issuance;
It will turn out that deposits increase one for one with reserves

Term loan costs

\[ b_1(y = 1, z = 1) = l_1^B + D_0 - S_0 (1 - \tau) - e_1 \]

if stressed bank

Interbank borrowing
Run Reserves post shrinkage
Symmetric Rational Expectations Equilibrium

- The market for term loans clears at date 0 (taking $r_1$ as given)
- The market for spot loans clears at date 1 at $r_1$.
- Capital supplies the residual: $e_1 = \alpha_1^{-1} r_1$

\[
\left[ \phi (1 - \theta) + \theta \right] \alpha_1^{-1} r_1 = \theta \left[ I_1 + (D_0 - D_0^F) \right] - \left[ \phi (1 - \theta) + \theta \right] S_0 (1 - \tau)
\]

- How does the equilibrium rate $r_1$ change with the level of reserves?

Additional liquidity raised via capital issuances
Firm's Investment demand
Retail Depositor run ("leakage")
Unencumbered liquidity with stressed and tainted banks
Equilibrium

• The market for term loans clears at date 0 (taking $r^*_1$ as given)
• The market for spot loans clears at date 1 at $r^*_1$.
• Capital supplies the residual: $e_1 = \alpha^{-1}_1 r_1$

\[
[\varphi(1-\theta) + \theta] \alpha^{-1}_1 r_1 = \theta \left[I_1 + (D_0 - D^F_0)\right] - [\varphi(1-\theta) + \theta] S_0 (1-\tau)
\]

What matters therefore is whether...

\[
\theta > \frac{\varphi(1-\tau)}{\tau + \varphi(1-\tau)}
\]

• If inter-bank market shut ($\varphi = 0$), inter-bank rate *always* increases in reserves
• If inter-bank market fully open ($\varphi = 1$), then this is so whenever $\theta > (1-\tau)$
Model solution and implications

Reserves and financial fragility, market failure, equity capital requirements
When is the money market stressed?

\[ \theta > \frac{\varphi(1-\tau)}{\tau + \varphi(1-\tau)} \]

“Counter-intuitive” case: High aggregate risk, high shrinkage, high hoarding

Depositors demand more than the post-shrinkage available reserves

\[ r_1 = \alpha_1 f(r_1, S_0) \]

\[ S_0 \text{ increases} \]

\[ S_0 = 0 \]

\[ S_0 \text{-critical} \]

\[ S_0 \text{-high} \]

\[ S_0 \text{-low} \]
Corporate sector is a net demander of liquidity (when $r_{-1} = 0$)

$$NLS < 0$$

Low aggregate risk $\theta$, Low shrinkage $\tau$, Low hoarding $(1 - \phi)$

Reserves must be set high

$$\theta < \frac{\phi(1 - \tau)}{\tau + \phi(1 - \tau)}$$

High aggregate risk, High shrinkage, High hoarding

Reserves must be set low

$$\theta > \frac{\phi(1 - \tau)}{\tau + \phi(1 - \tau)}$$
Market failure and capital regulation

• The planner would like to keep interbank rates at zero at date 1.
• In the case shown above, the planner can choose the level of reserves appropriately if they are only concerned about financial stability.
• But the level of reserves may be set with a monetary policy objective.
  • If so, may be conflict with financial stability objectives
• Is there a market failure?
  - Yes, too many deposits, given the pecuniary externality on interbank rates
  - As reserves increase, there can be too much creation of claims to immediacy
  - Banks do not internalize the effect of their liability structure (or asset encumbrances) on interest rates and real economy (Lorenzoni, 2008; Stein, 2012)
• High reserves need tighter ex-ante capital adequacy
  - Modifies Liang and Parkinson (2020)
Flight to safety and hoarding

Will surplus banks necessarily channel liquidity to the deficient ones?
Altered assumptions

• Recall that flighty deposits migrate to “safe” banks

• Let safe banks earn a (small) convenience yield $\delta$ on extra reserves
  - The value of having liquid assets in case of additional stress
  - A private transfer from other banks’ franchise values to the safe banks

• To be perceived as “safe” healthy banks must not get “tainted” by being seen as connected to the stressed banks via inter-bank loans

• However, as liquidity stress rises, higher interbank rate induces such loans

• What fraction $\varphi$ of unstressed banks lends? BREAKEVEN RATE

• Can inter-bank markets remain shut altogether ($\varphi = 0$)? AUTARKY
Breakeven rate for inter-bank market to open up

\[ V_1^\varphi (y = 1, z = 0) = \left( (r_1 - \delta) S_0 (1-\tau) + \frac{r_1^2}{2\alpha_1} \right) \]

\[ V_1^{1-\varphi} (y = 1, z = 0) = \frac{\delta S_0 (1-\tau)(\theta + (1-\theta)\varphi)}{(1-\theta)(1-\varphi)} \]

\[ V_1^\varphi = V_1^{1-\varphi} \]

**"Tainted" Bank Franchise value**

**"Safe" Bank Franchise Value**

\[ (1-\varphi) = \frac{\delta S_0 (1-\tau)}{(1-\theta) \left[ r_1 S_0 (1-\tau) + \frac{r_1^2}{2\alpha_1} \right]} \]
\[ \delta = 0.2, \tau = 0.2 \]
\[ \theta = 0.6 < (1 - \tau) \]

**Low reserves:**
Banks manage with own funding

**Moderate reserves:**
Banks need liquidity but inter-bank markets shut (Autarky)

**High reserves:**
Banks need liquidity and inter-bank markets open up as \( r_1 \) is attractive

Interbank rate increases enough to open the inter-bank market

\[ \frac{\delta}{\delta \tau} = 0.6 \quad (1) \]
\[ \tau = 0.2 \]
\[ \theta = 0.6 < (1 - \tau) \]

As the convenience yield on reserves increases...

Inter-bank markets remain endogenously shut for longer, and Inter-bank rates in stress times rise more...
\[ \tau = 0.2 \]
\[ \theta = 0.6 < (1 - \tau) \]

As the convenience yield on reserves increases, more surplus banks hoard, and the extent of inter-bank liquidity transfer reduces.
Implications

• Benchmark model assumed inter-bank markets are always open

• Flight to safety and liquidity hoarding imply this need not be the case

• As reserves increase, inter-bank markets can remain closed for a larger range of parameters as hoarding incentives strengthen when $\delta > 0$
  - Benefits to hoarding safe-to-flight deposits rise
  - Breakeven rate at which inter-bank market opens up rises

• The greater the perceived benefit $\delta$ of reserves hoarding during stress, the more likely it is that higher reserves lead to financial fragility
Ex-post central bank interventions

• Crowd out private ex-post lending by surplus banks

• Interventions require collateral
  - Eligible collateral? Duration? Maturity matching of assets and liabilities?
  - Stigma in borrowing from the central bank facilities?

• Unsecured interventions
  - In principle, can solve all money-market problems, BUT... typically distort asset prices

• Ex-ante moral hazard
  - Create greater balance sheet illiquidity, insolvency, and herding by banks

• Ever increasing intervention

“When Norges Bank keeps reserves relatively high for a period, it appears that banks gradually adjust to this level... With ever increasing reserves in the banking system, there is a risk that Norges Bank assumes functions that should be left to the market. It is not Norges Bank’s role to provide funding for banks...If a bank has a deficit of reserves towards the end of the day, banks must be able to deal with this by trading in the interbank market.”
Discussion and Robustness issues
Endogenizing shrinkage of reserves ($\tau$)

• Speculation:

- Banks must hold some margins against prime-brokerage services
- Search costs for prime-brokerage services reduce in unencumbered liquidity
- This way, reserves can get encumbered away from stress-time withdrawals

- Indeed, stress may necessitate that encumbrance ($\tau$) rise pro-cyclically (in

- In practice:
  - CCP initial margins/guarantee funds, often kept at central banks
  - March 2020 Treasury relative trades (Barth and Kahn, 2021) show positions grew from $200 bln in 2013 to $800 bln by 2020, needing significant margins ex post
Speculation (formally...)

\[ \kappa = \text{Margin to be set aside per speculative position} \]

\[ \begin{align*}
\text{Max}_x & \left(1 - \frac{q}{\theta}\right)[\eta - f] x - \frac{v x^2}{2 \left(S_0 - \kappa \bar{x}\right)} \\
\Rightarrow \kappa \bar{x} &= \frac{S_0 \kappa \left(1 - \frac{q}{\theta}\right)(\eta - f)}{\nu + \kappa \left(1 - \frac{q}{\theta}\right)(\eta - f)} = \tau S_0
\end{align*} \]

Expected Speculative Return net of 
Prime-brokerage Fee
Search Costs for Prime-brokerage Services:
Increase in Speculative position,
Decrease in Unencumbered reserves
Endogenizing shrinkage of reserves ($\tau$)… cont’d

• Regulation (intra-day liquidity and resolution-planning requirements):
  - Must be maintained by each bank even during stress (Diamond-Kashyap, 2016)
  - Jamie Dimon, CEO of JP Morgan, on 2019 episode:

  “[…] we have $120\,\text{billion} in our checking account at the Fed, and it goes down to $60\,\text{billion} and then back to $120\,\text{billion} during the average day. But we believe the requirement under CLAR and resolution and recovery is that we need enough in that account, so if there’s extreme stress during the course of the day, it doesn’t go below zero.” (D’Avernas and Vanderweyer (2021))
Shadow banking and maturity-matching

- What if reserves are allowed to be held by non-banks (RRP facilities)?

- Shadow banks likely to maturity-match assets and liabilities
  - The risk of rollover costs on deposits; higher premia in long-term financing
  - More short-term assets facilitate greater short-term liabilities

- Simply raising capital requirements on banks may not suffice

- Both reserves and deposit-financing of reserves move to shadows
  - Reinstatement in April 2021 of the Supplementary Leverage Ratio on banks
  - Banks “pushing away” reserves and corporate deposits to money market funds
Conclusion

Large central bank balance-sheet -> Liquidity dependence of the financial system

Reserves supply creates its own ex-post demand for reserves, limiting the central bank’s ability to use balance-sheet size for financial stability and growth

- More reserves is not a permanent solution

Reserve issuance may not crowd out private deposit-like claims, may in fact (as the evidence shows) enhance it.

- Contrast with Stein, 2012; Greenwood, Hanson and Stein, 2015, 2016.

Limits on central bank balance-sheet size from financial stability perspective?
Reserve requirements

• Ex-ante reserve requirements: \( D_0 \leq \zeta S_0 \)

• Up to a level of reserves, serve effectively as a constraint on deposits and incentivize capital issuance

• Our model suggests these may be worth reconsidering in the modern financial system

• Constrain lending at date 0 but stabilize lending in stress at date 1
Interest on excess reserves (IOER) and privately optimal reserves holdings

• Privately optimal demand for reserves in general differs from the socially optimal levels
  - Private costs (IOER) factored in
  - Private gains from lending in inter-bank markets factored in
  - BUT... social benefits/costs in the form of impact on inter-bank rates ignored

• Central bank can “fine tune” the IOER to align the private desire for reserves with the social one
  - Can reduce the “hot potato” syndrome with large reserves

• This does not, however, address the issue of whether more or less reserves are desirable in the first place