Why flooding banks with central bank reserves may not expand liquidity

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

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- Unprecedented expansion of central bank balance sheets since 2008
  - Central banks issue reserves (central bank liability) to commercial banks (commercial bank asset) while buying bonds
    - Most liquid asset on planet.
- Yet…
- Surprisingly fragile liquidity conditions in money markets
  - Unexpectedly large spikes in repo markets in September 2019
  - Dash for cash in March 2020
  - UK Gilts: LDI (pension) crisis following the “mini budget” in October 2022
  - Uninsured depositor runs based on bank solvency concerns in March 2023
- Why?

- Till recently, only commercial banks held reserves
- Fed buys securities, pays with reserves (Fed money).
  - From public
  - From commercial bank

Initial Balance Sheet Conditions

FEDERAL RESERVE	
Assets	**Liabilities**
Treasury securities	Reserves held by banks Cash held by the Treasury

BANKING SECTOR	
Assets	**Liabilities**
Treasury securities Reserves at the Fed	Deposits

PUBLIC	
Assets	**Liabilities**
Deposits Treasury securities	Wealth

FEDERAL RESERVE	
Assets	**Liabilities**
Treasury securities +$1	Reserves held by banks +$1 Cash held by the Treasury

BANKING SECTOR	
Assets	**Liabilities**
Treasury securities Reserves at the Fed +$1	Deposits +$1

PUBLIC	
Assets	**Liabilities**
Deposits +$1 Treasury	

Expansion financed with bank deposits

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

Initial Balance Sheet Conditions

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Assets	**Liabilities**
Treasury securities Reserves at the Fed	Deposits

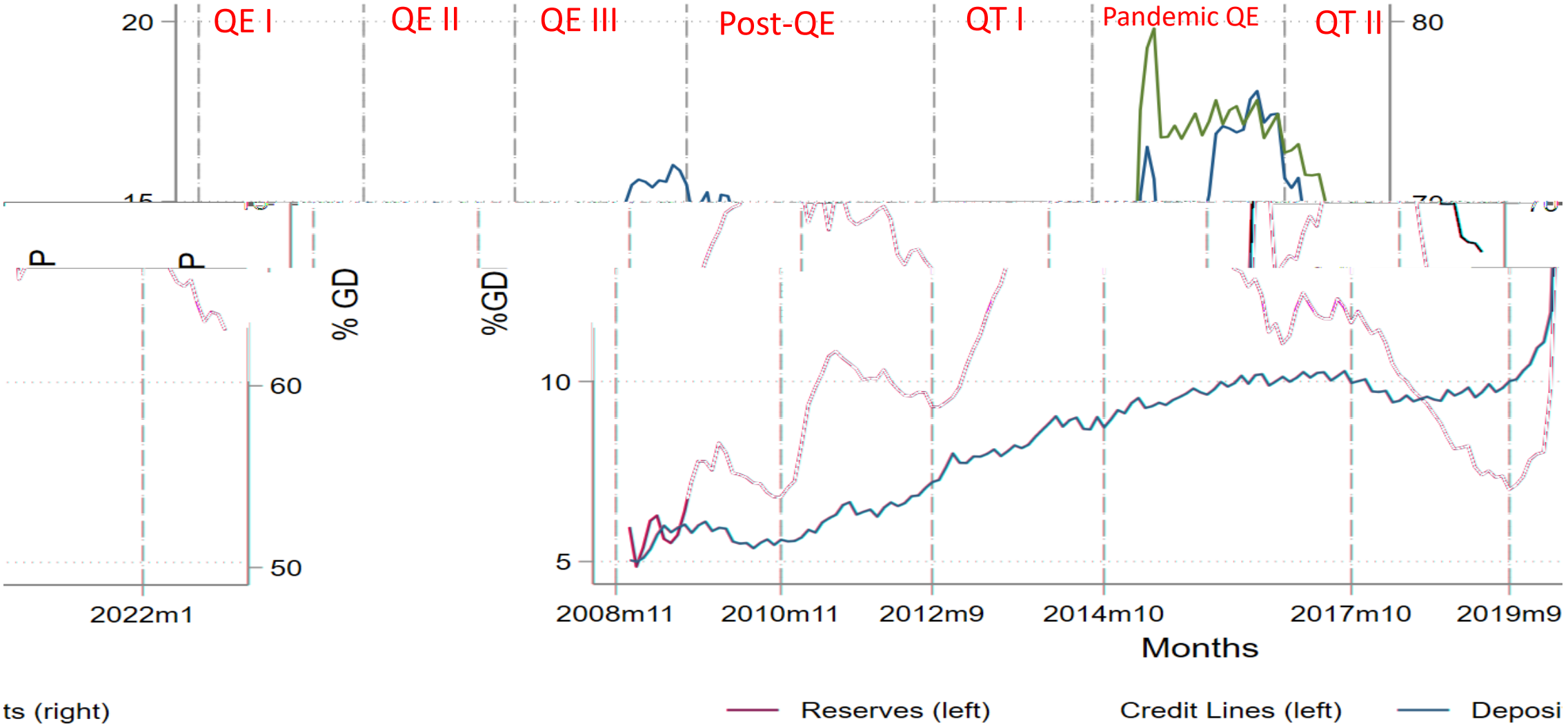
After purchase

FEDERAL RESERVE	
Assets	**Liabilities**
Treasury securities +$1	Reserves held by banks +$1 Cash held by the Treasury

BANKING SECTOR	
Assets	**Liabilities**
Treasury securities -$1 Reserves at the Fed +$1	Deposits

Asset swap with banks

Source: "How the Fed Changes the Size of its Balance Sheet" (Leonard, Martin and Potter, *Liberty Street Economics*, 2017)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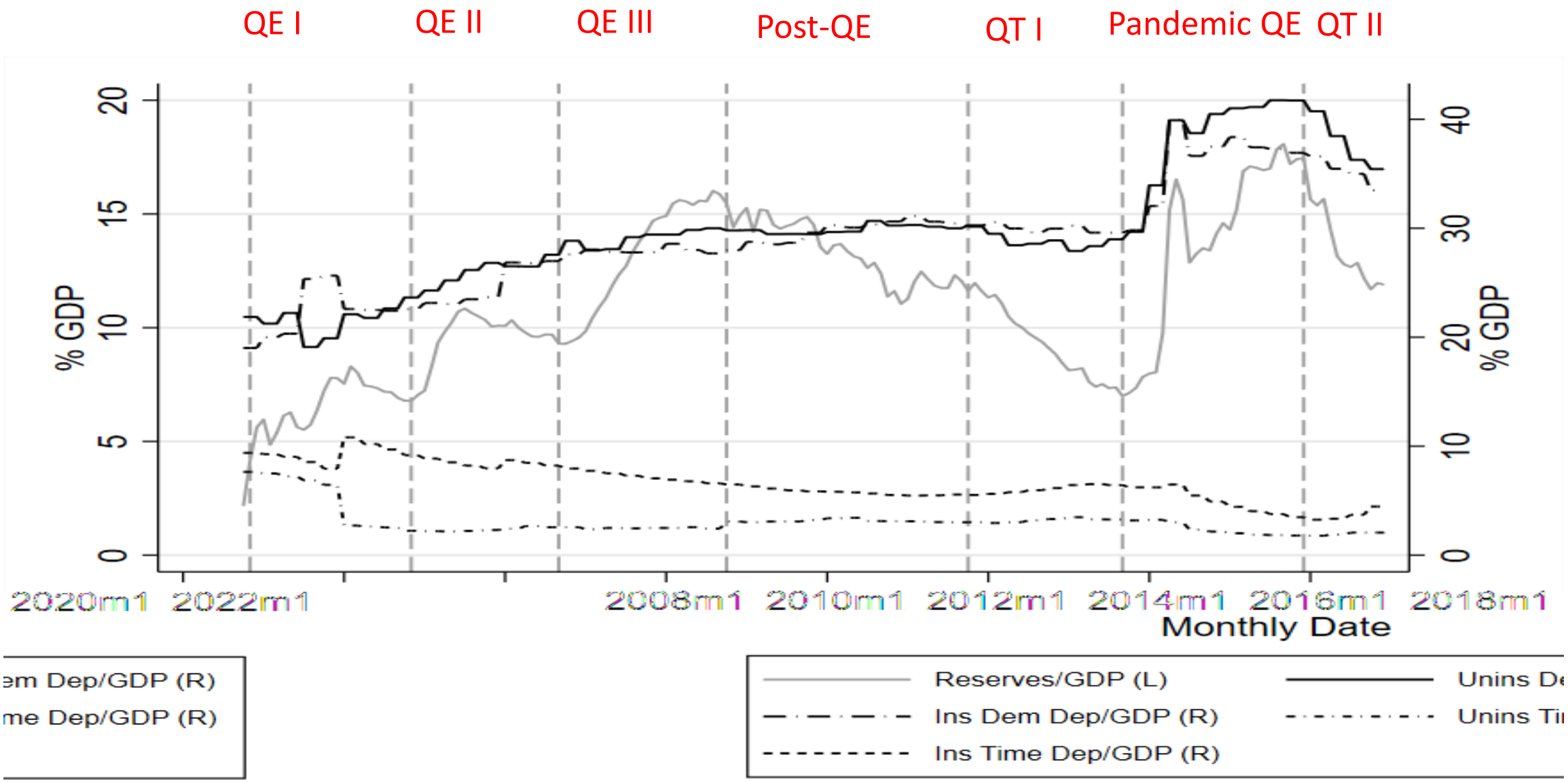
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- Central bank reserve expansion works through commercial bank balance sheets.
- There seems to be hysteresis; QT is not a reversal of QE.
- Can (some of) this be modeled? A micro-banking model of QE/QT.

Implications:

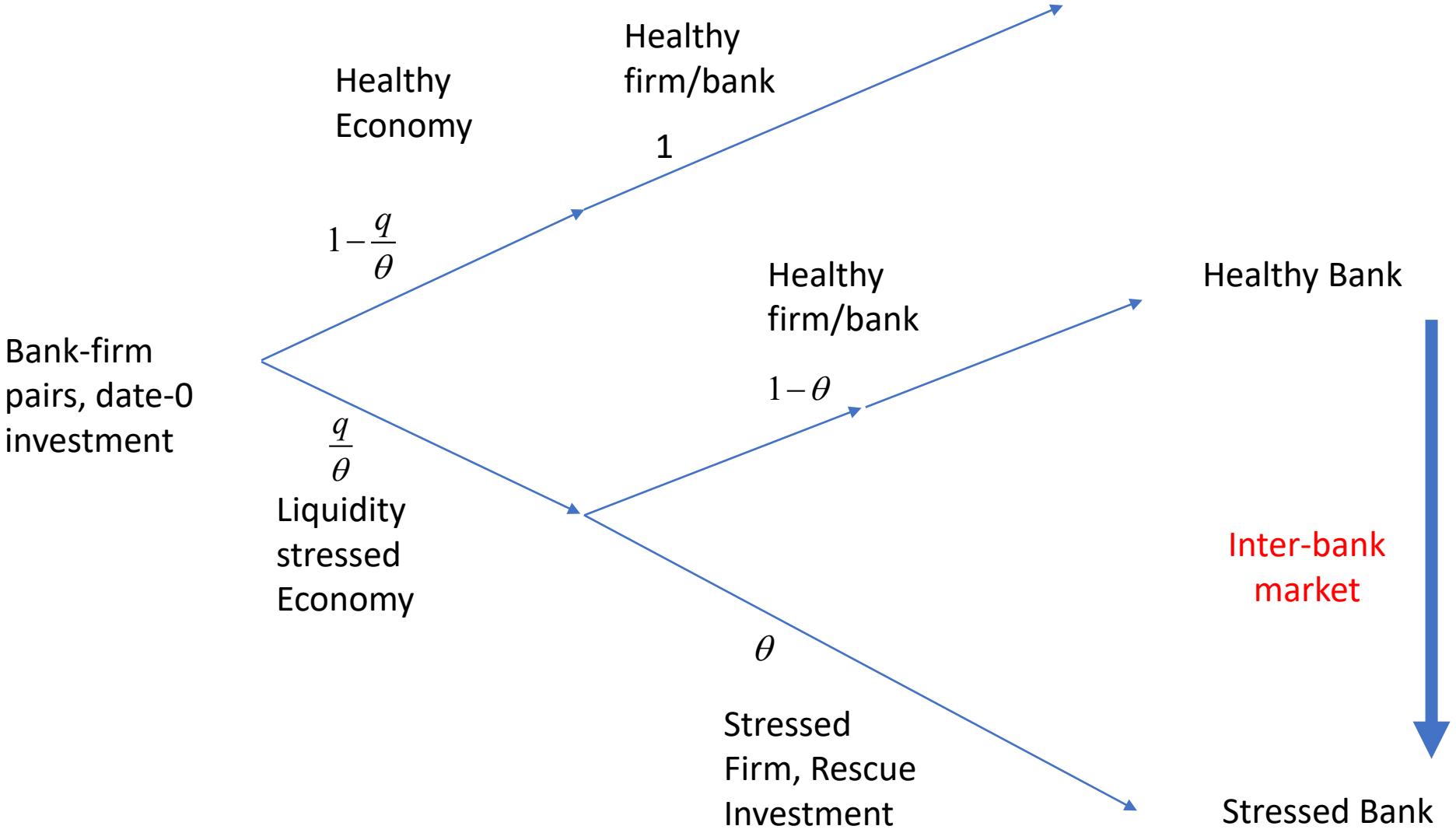
- Ordinarily, far less spare liquidity than suggested by simple reserve expansion.
- In *extremis*, higher the reserves issued ex ante, more fragile the interbank markets and higher the inter-bank rates in stress
- This can have adverse real consequences on corporate investments

Firms, Banks, Investors, … Interbank market to shuffle around liquidity

- Bank firm pairs
  - “regionally” or “sectorally” matched
- Firm and bank owners are risk-neutral, expected profit-maximizers
- Firms:
  - Invest I_0 at date 0 to obtain returns at date 2 , funded by
    - Firm owners’ initial wealth W
    - Term loans from banks L
  - Place deposits D_0^F with bank.

- Banks at date 0:
  - Assets
    - Long term loan to their firm
    - Liquid reserves S_0 that shrink by encumbrance τ (net of interest on reserves) at date 1
  - Liabilities I: Uninsured deposits D_0 from risk-averse investors at date 0
    - Will run if firm/bank stressed at date 1
  - Liabilities II: Capital from deep-pocket risk-neutral investors
    [or alternatively, costly-to-raise "core" deposits that do not run]
    - Stable but costly capital funding e_t available at date t
    - Quadratic costs $\frac{\alpha_t e_t^2}{2}$

- Economy stressed with probability q / θ, healthy otherwise.
- Conditional on economy stress, probability θ that specific bank-firm pair's investment is stressed and has to be "rescued" with additional investment I_1


Healthy
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firm/bank
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Healthy
firm/bank
Healthy Bank
Bank-firm
pairs, date-0
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$\frac{q}{\theta}$
Liquidity
stressed
Economy
Inter-bank
market
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Stressed
Firm, Rescue
Investment
Stressed Bank

Date 0

Date 1

- If bank-firm pair stressed
  - Firm will withdraw deposit and ask for additional loan to fund its optimal date-1 “rescue” investment.
  - Risk averse depositors will run.
- Stressed banks will raise funding

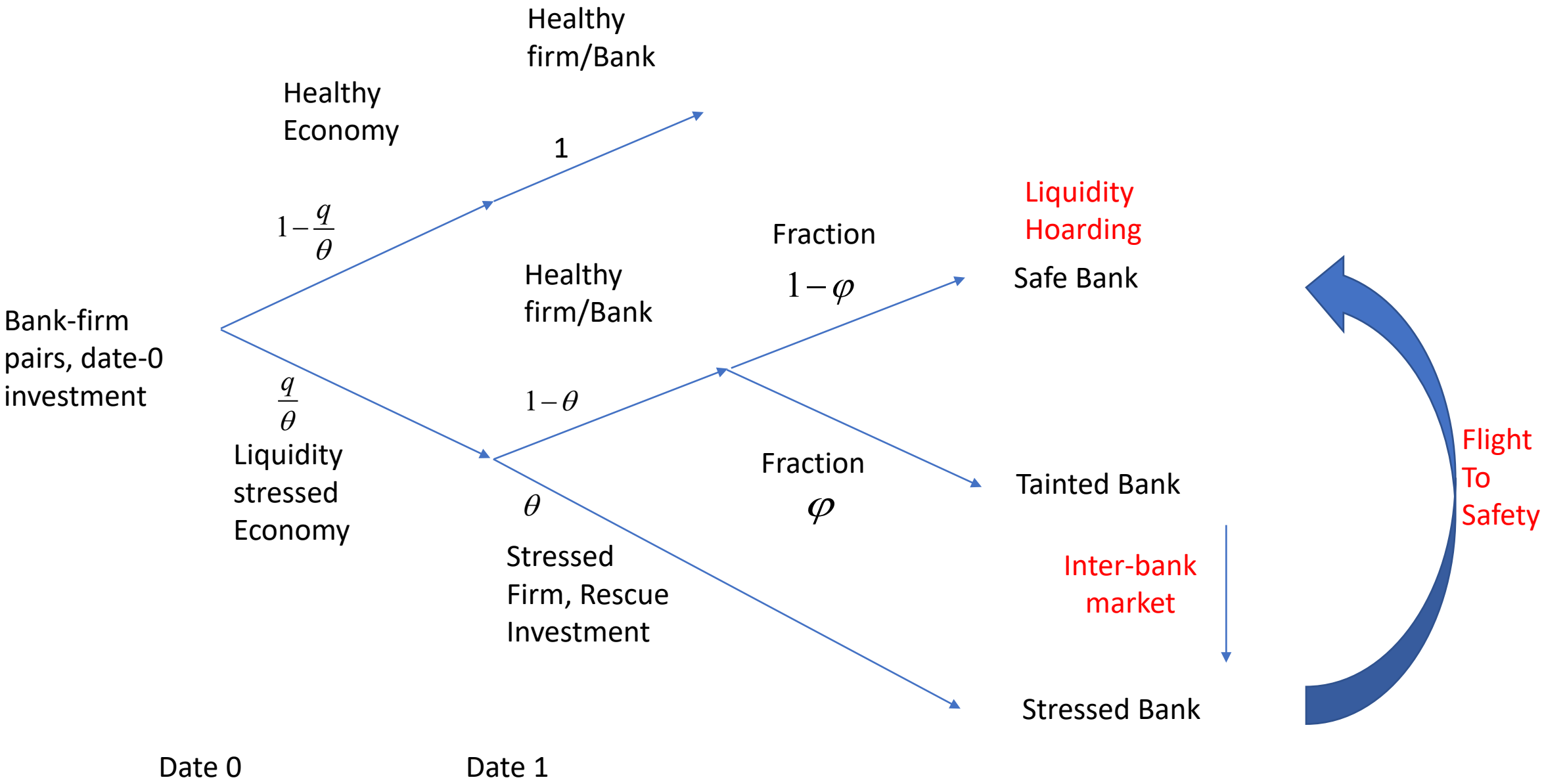
  (1) From the date-1 inter-bank market at rate r_1.

  (2) They also can raise date-1 capital e_1

- Only a fraction φ of healthy banks lend to stressed banks in the inter-bank market.

- Remaining fear being tainted: (1 - φ) “safe” healthy banks
  - forego lending
  - but being seen as safe, receive flight-to-safety deposits that run from stressed banks.

- φ fixed for now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Investment
Inter-bank
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Stressed Bank
Date 0
Date 1

- Date 0:

Term loan

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

- Date 1:

Spot loan

$$\underset{l_1}{Max}\ g_1(I_1)-l_1^F\left[1+\gamma+r_1\right]$$

Rescue investment
(risky at date-2 but no date-1 solvency concerns)

- Budget constraints:

$$\text{s.t. } I_0 = L_0^F + W_0^F - D_0^F \text{ and } I_1 = l_1^F + D_0^F$$

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

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

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

$$b_1(y=1,z=1) = l_1^B + D_0 - S_0(1-\tau) - e_1 \qquad \text{if stressed bank}$$

$$b_1(y=1,z=0) = -S_0(1-\tau) - e_1 \qquad \text{if tainted bank}$$

- The market for spot loans clears at date 1 at r_1.
- Stressed and tainted banks also issue capital at marginal cost $\alpha_1 e_1$. Since banks will not issue at a higher cost than r_1, it must be that $e_1 = \alpha_1^{-1} r_1$

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

Increases one for one with S_0

Additional liquidity raised via date-1 capital issuances

Firm's fund requirement for rescue investment

Risk-averse depositor run

Unencumbered liquidity with stressed and tainted banks

- How does the equilibrium rate r_1 change with S_0?
- Extra unit of reserves creates θ demand for liquidity from stressed banks
- Creates $(1-\tau)[\varphi(1-\theta)+\theta]$ supply of liquidity

- Rearranging, more ex-ante reserves enhance liquidity stress r_1 if

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

- If the inter-bank market is shut ($\varphi = 0$), the date-1 shadow inter-bank rate *always* increases in ex-ante reserves if $\tau > 0$.
- If inter-bank market fully open ($\varphi = 1$), then the shadow interbank rate increases whenever

$$\theta > (1-\tau)$$

- Endogenize φ, the extent of hoarding by introducing a small but positive convenience yield on reserves.
- Interesting result: the date-1 interbank market can shut down under a variety of circumstances.
  - The greater the convenience yield on reserves in stress, the larger the parameter range over which the interbank market shuts down

- Endogenize τ , the shrinkage of reserves, by adding in how QT works

- Deposits fleeing distressed banks migrate to “safe” banks
- Let safe banks earn a (small) *convenience yield* δ on reserves
  - value of liquidity in case of additional stress
- To be perceived as “safe” and attract deposits, healthy banks must not get “tainted” by lending to stressed banks.
- But they then forego the return r_1 from lending in the interbank market.
- Equilibrium fraction of banks φ that lend in the interbank market
  - equates profits from lending to profits from flight to safety deposits

$$V_1^{\varphi} = \left[(r_1 - \delta) S_0 (1-\tau) + {r_1^2}/{2\alpha_1} \right]$$

"Tainted" Bank value

$$V_1^{1-\varphi} = \frac{\delta S_0 (1-\tau)(\theta + (1-\theta)\varphi)}{(1-\theta)(1-\varphi)}$$

"Safe" Bank value

$$V_1^{\varphi} = V_1^{1-\varphi} \Rightarrow (1-\varphi) = \frac{\delta S_0 (1-\tau)}{(1-\theta)\left(r_1 S_0 (1-\tau) + {r_1^2}/{2\alpha_1} \right)}$$

Breakeven Inter-bank rate For (some) Surplus Banks To Lend

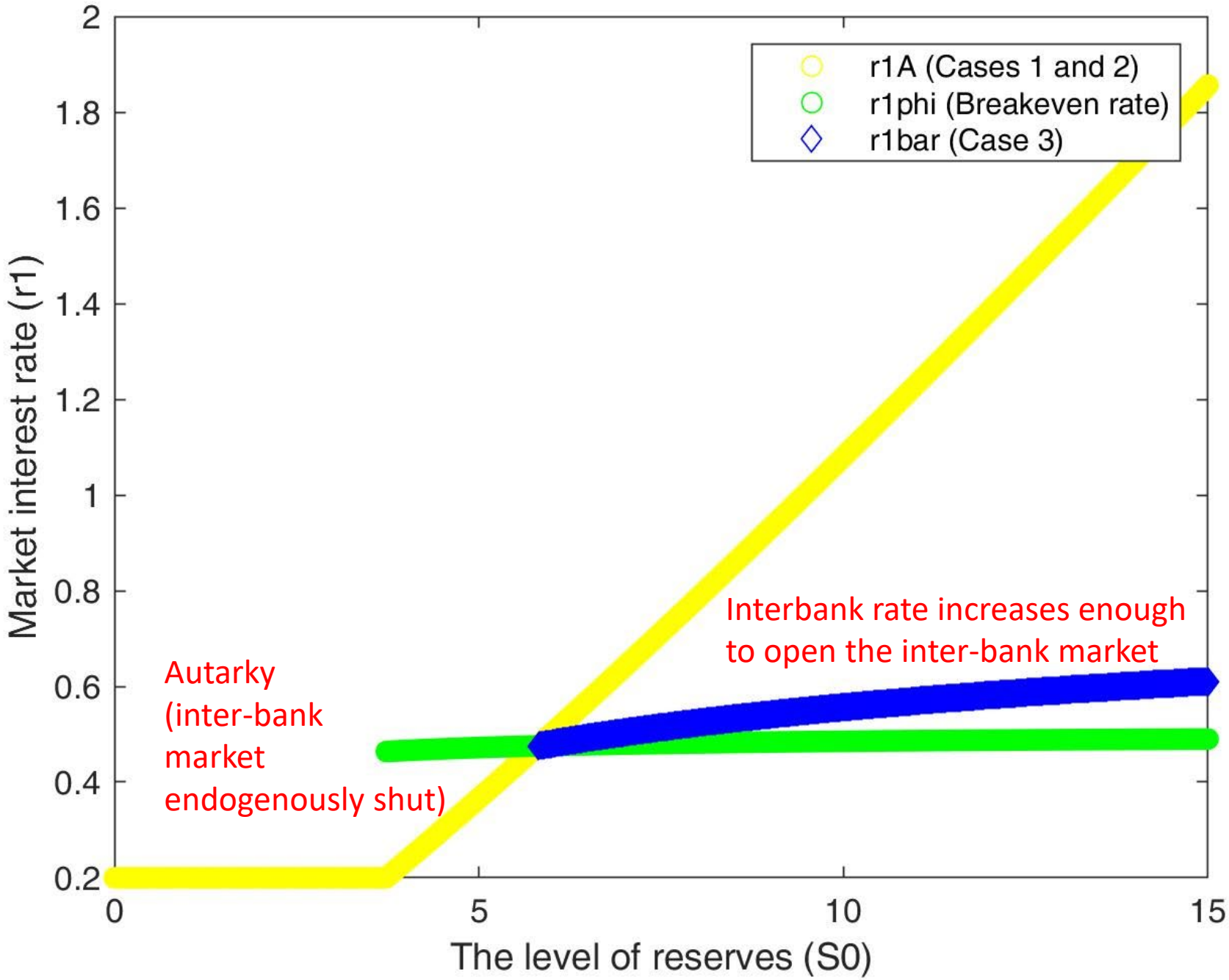
$$\delta = 0.2, \tau = 0.2$$

$$\theta = 0.6 < (1 - \tau)$$

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 r1 is attractive



- The greater the perceived benefit δ of reserves hoarding during stress, the more likely it is that higher ex ante reserves lead to financial fragility

- Endogenous $\delta(r_1)$ may imply the interbank market never opens.

τ

- Suppose QT consists of the central bank selling securities
- Assume this takes place before uncertainty is realized.
- The central bank can sell securities
  - To banks : Asset swap
    - This will shrink bank reserves, without shrinking bank deposits.
  - To the public
    - This will shrink bank reserves and deposits
- In 2017-19, largely seemed to be asset swap

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Asset swap with banks

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

- Central bank wants to sell securities
- Bank is prime broker with public clients holding deposits in bank.
  - Bank balance sheet contraction as clients pay for securities with their deposits
- Or it can buy securities itself.
  - Asset swap
- Assume securities are not as liquid as reserves, but can be “repo’ed” for reserves in a stressed market at a haircut h.

In stressed state

- If a bank stressed,
  - Balance sheet contraction: It gave up $1 of reserves for $1 of deposit shrinkage
  - Asset swap: repo the security for *(1-h)* of reserves, but have to pay 1 to deposits
  - It is always better off having contracted its balance sheet.
- If a bank healthy and wants to lend in interbank
  - Balance sheet contraction: It gave up $1 of reserves which it cannot lend
  - Asset swap: It has *(1-h)* of repo'ed reserves which it can lend in the interbank market.
  - Prefers asset swap
- Ex ante, if θ small, φ high, and *h* small, asset swap dominates.

=> Reserve shrinkage τ relative to deposits high.

- Suppose banks assume that $r_1 > 0$ in the liquidity stressed state
- Then banks desire liquid assets in QT ($s = 1$) if and only if

$$\left[1+\frac{(1-\theta)}{\theta}\varphi\right] > \frac{p}{(1-h)}$$

- Likely the case if
- Securities are priced low (we assume in the paper $p = 1$)
- Expected haircut in LOLR is low
- Expected probability of liquidity stress is low
- Intuition: Individual bank incentives to keep reserves, taking as given the aggregate liquidity risk, engender aggregate liquidity risk!

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

- Central bank buys bonds from public, creates reserves deposited in commercial banks.
- Are reserves financed with deposits or do banks rebalance deposits with new capital issuances?

- The way reserves are financed matters as <u>demand deposits will be a claim on reserves in future</u>

II. *Ex post*: Shrinkage and/or Additional encumbrances on reserves

- Quantitative Tightening (QT) shrinks reserves but need not shrink liquidity claims
  - Acharya, Chauhan, Rajan and Steffen (2022)
  - Equivalent to QT being an asset-swap with banks (QE being asset-swap with non-banks)

- Commercial banks reluctant to leave reserves idle – therefore sell contingent claims on liquidity – credit lines to non-bank financials and non-financials – so that reserves are "fully" or "efficiently" utilized (ACRS, 2022; Yankov, 2020).
- Regulation: liquidity requirements "lock up" reserves in stress scenarios (Diamond and Kashyap, 2016; Vandeweyer, 2019; others)
- Ratcheting: the level of reserves creates own supervisory demand (Nelson, 2019)

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

- High rate paid in the interbank market for reserves when the system is stressed.
- However, some surplus banks fear a "taint" from lending to needy.
- Instead prefer to stay "safe" and receive flight-to-safety deposits passively.

$\Rightarrow$Liquidity hoarding limits the ex-post availability of reserves.

[Hoarding can be for other reasons too, e.g., if runs are indiscriminate.]

- Ordinarily, far less spare liquidity than suggested by simple reserve expansion.
- In *extremis*, higher the reserves issued ex ante, more fragile the interbank markets and higher the inter-bank rates in stress
  - This can have adverse real consequences on corporate investments

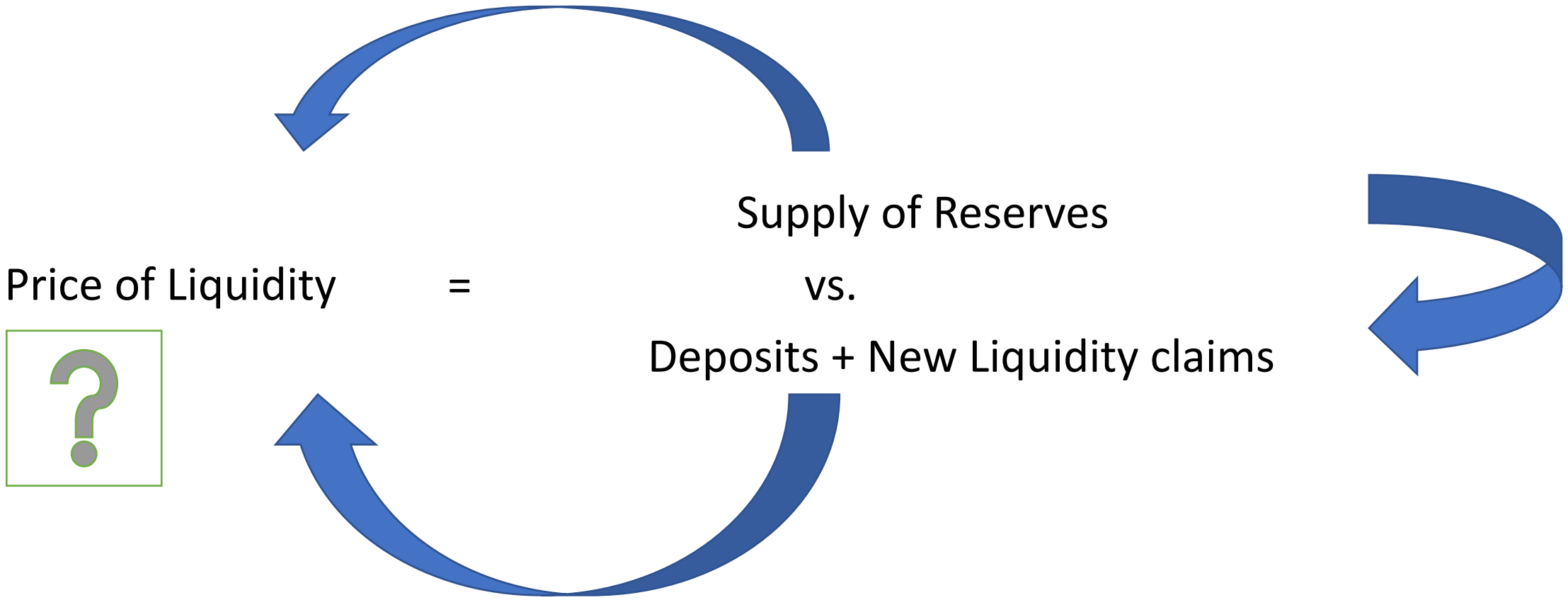
- Liquidity concerns would imply the central bank should set reserves such that $r_1 = 0.$
- But un-modeled monetary policy concerns in an era of too-low inflation might require setting reserves at a different level (QE).
- Divergence between concerns most likely when degree of liquidity stress rises in ex-ante reserves.
- If so, ex post liquidity stress will offset some of the beneficial effects of monetary policy when reserves are set too high from a liquidity perspective.
- Would capital requirements help?
  - No, when φ exogenous, private and social choice in capital structure coincide since we have only a pecuniary externality (unlike Lorenzoni (2008) or Stein (2012)).
  - With φ endogenous, social planner wants to set capital lower!

- Would more ex ante central bank balance-sheet expansion (Copeland, Duffie and Yang, 2021) work to alleviate ex post liquidity stress?
  - Under certain conditions could be a moving target!

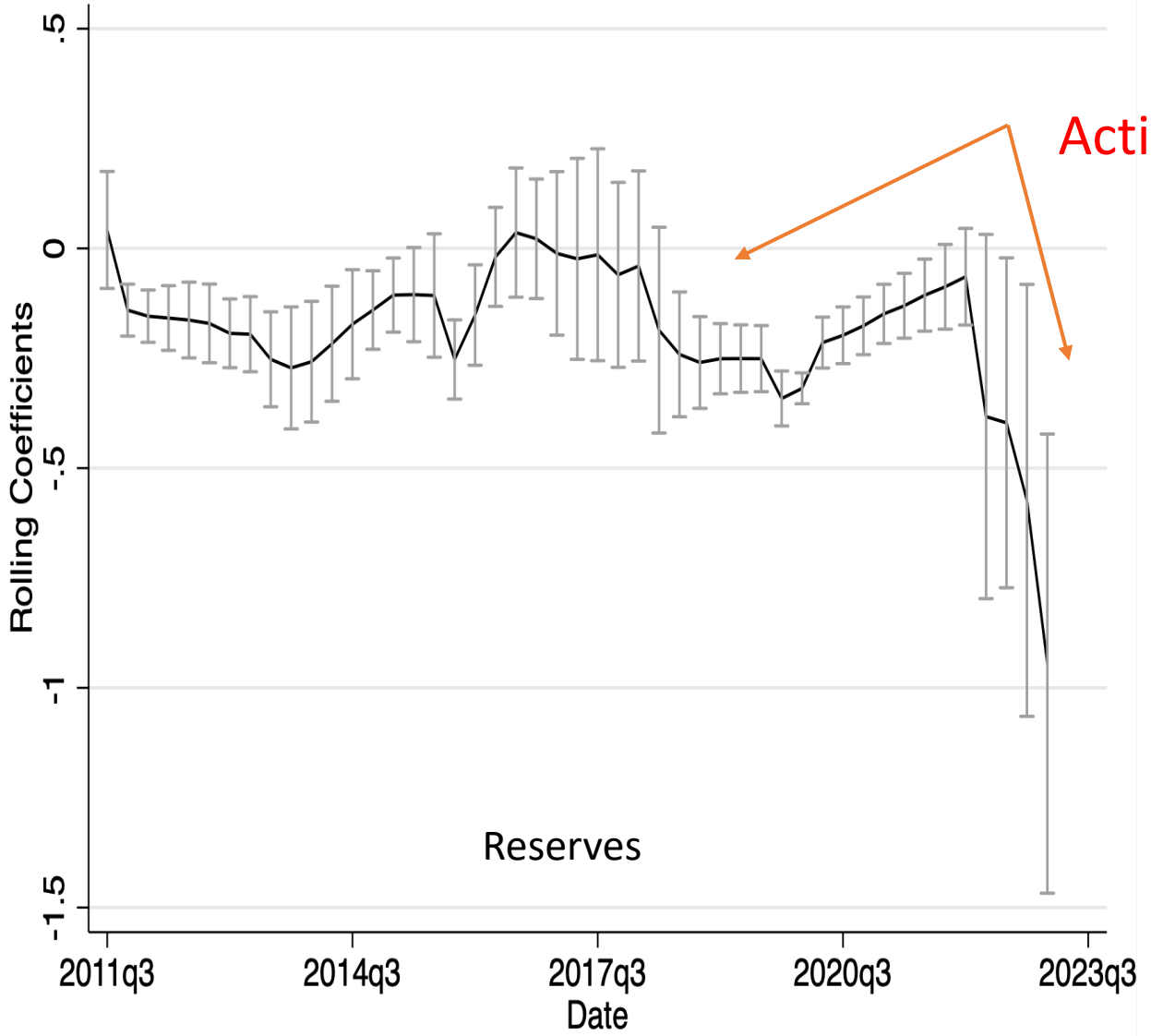
- Would reserve issuance crowd out deposit-like claims (Greenwood, Hanson and Stein (2015, 2016))?
  - Our base model says it would enhance them.
  - Requires reserves to be held by non banks (e.g., money market funds).

Yes but

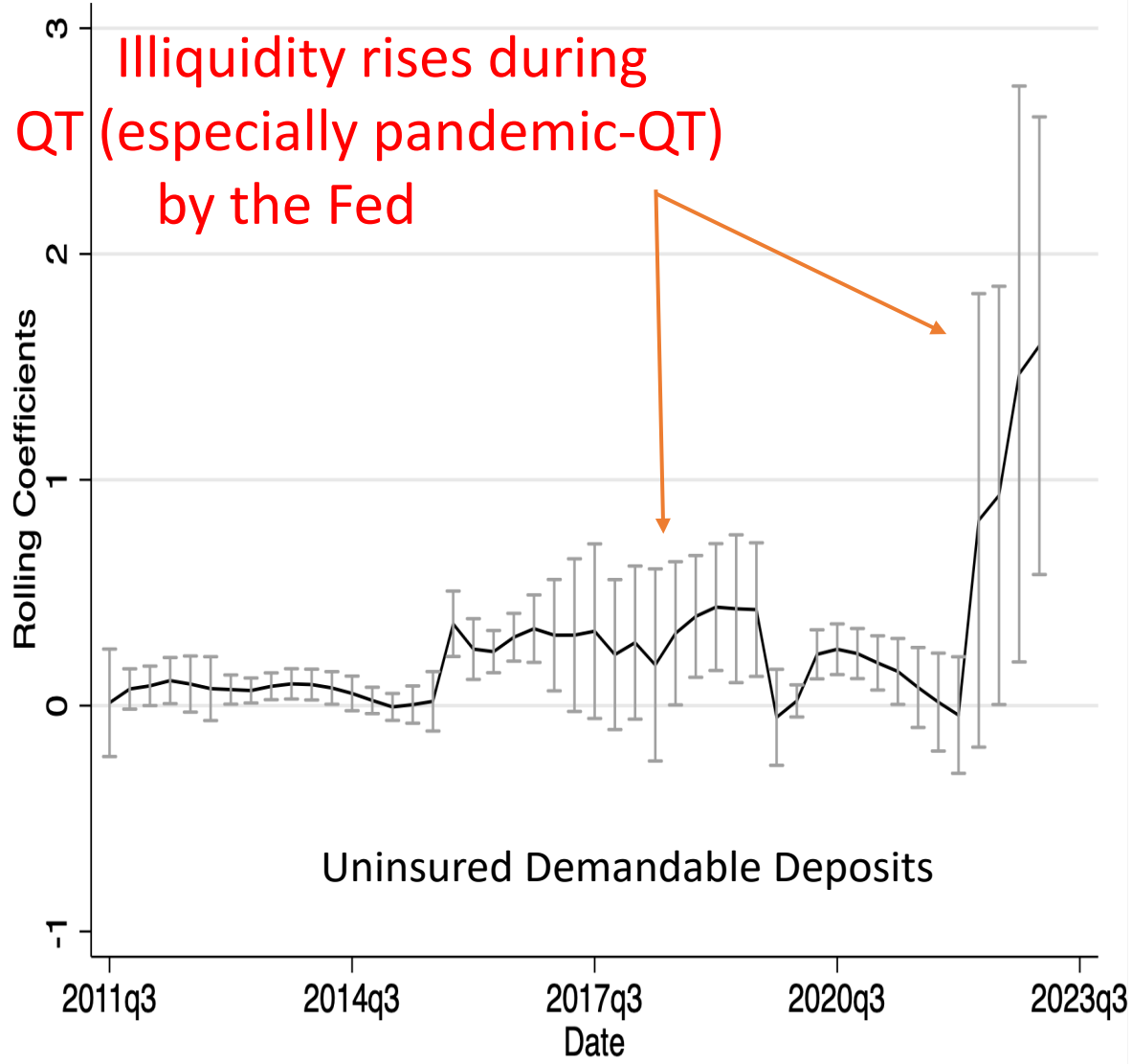
- Crowds out private ex-post lending by surplus banks – more hoarding
- Central banks typically lend against collateral
  - High quality collateral financed with deposits does not add additional liquidity
- Unsecured interventions or lending against all manner of assets (March 2023)
  - In principle, can solve all liquidity problems, BUT… typically distort asset prices and has fiscal component: moral hazard
- Ex-ante moral hazard
  - Acharya, Shin and Yorulmazer (2011), Diamond and Rajan (2012), Farhi and Tirole (2011)
- Ratcheting intervention: liquidity dependence.



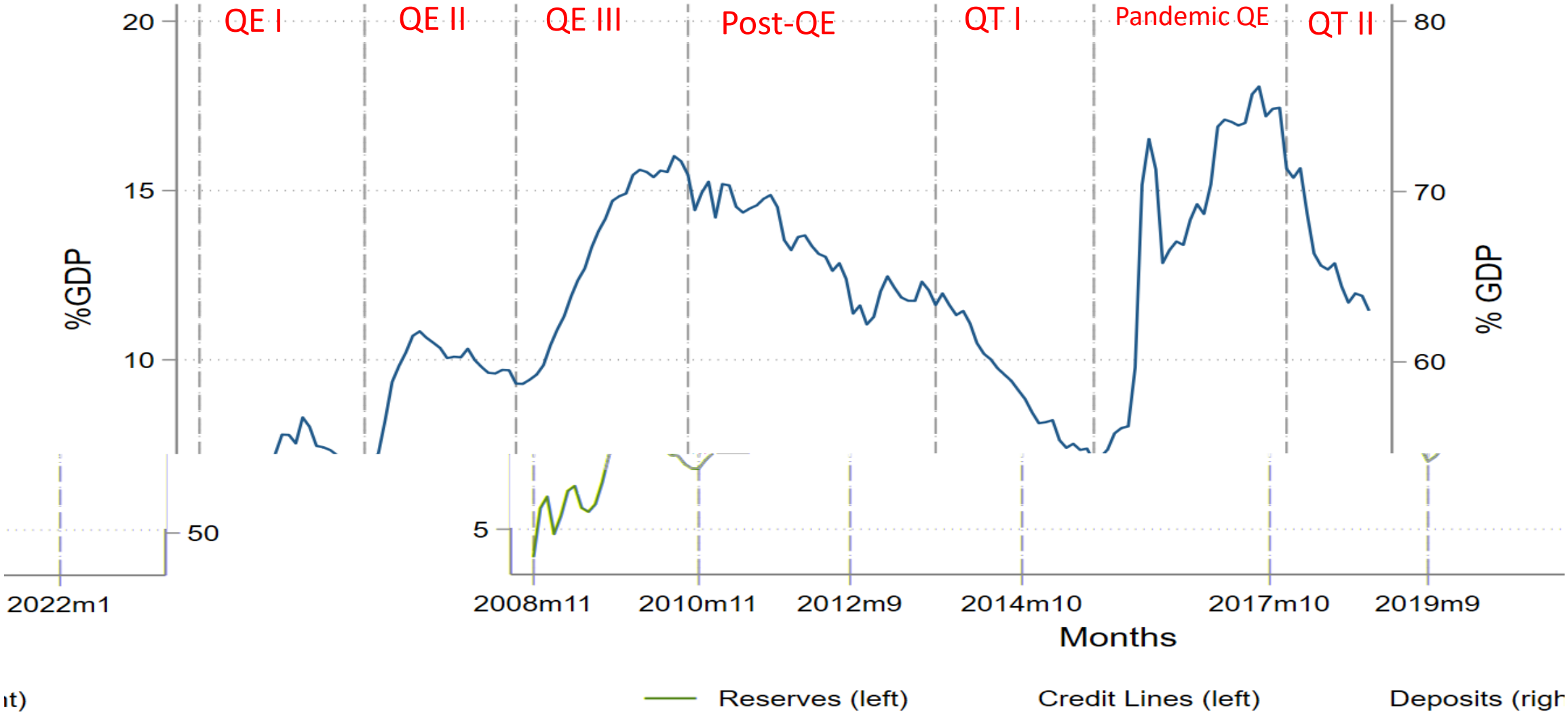
- <u>Supply of reserves creates its own demand, new claims, which can destabilize</u>



Illiquidity rises during Active QT (especially pandemic-QT) by the Fed



- Large central bank balance sheet need not imply the financial system has plenty of spare liquidity.
- Supply of ex-ante reserves creates its own ex-post demand
- Limits the central bank's ability to use an expanded balance-sheet to enhance stability or growth
- Take care when you shrink the central bank balance sheet: hysteresis.
    - Engage in QT while "feeling the stones" for financial fragility
    - Monitor claims on liquidity also to see if they shrink.
    - Alternative: Target QT as sales to non-banks?
- Revisit desirable scale, scope, duration of QE: "pushing on a string"?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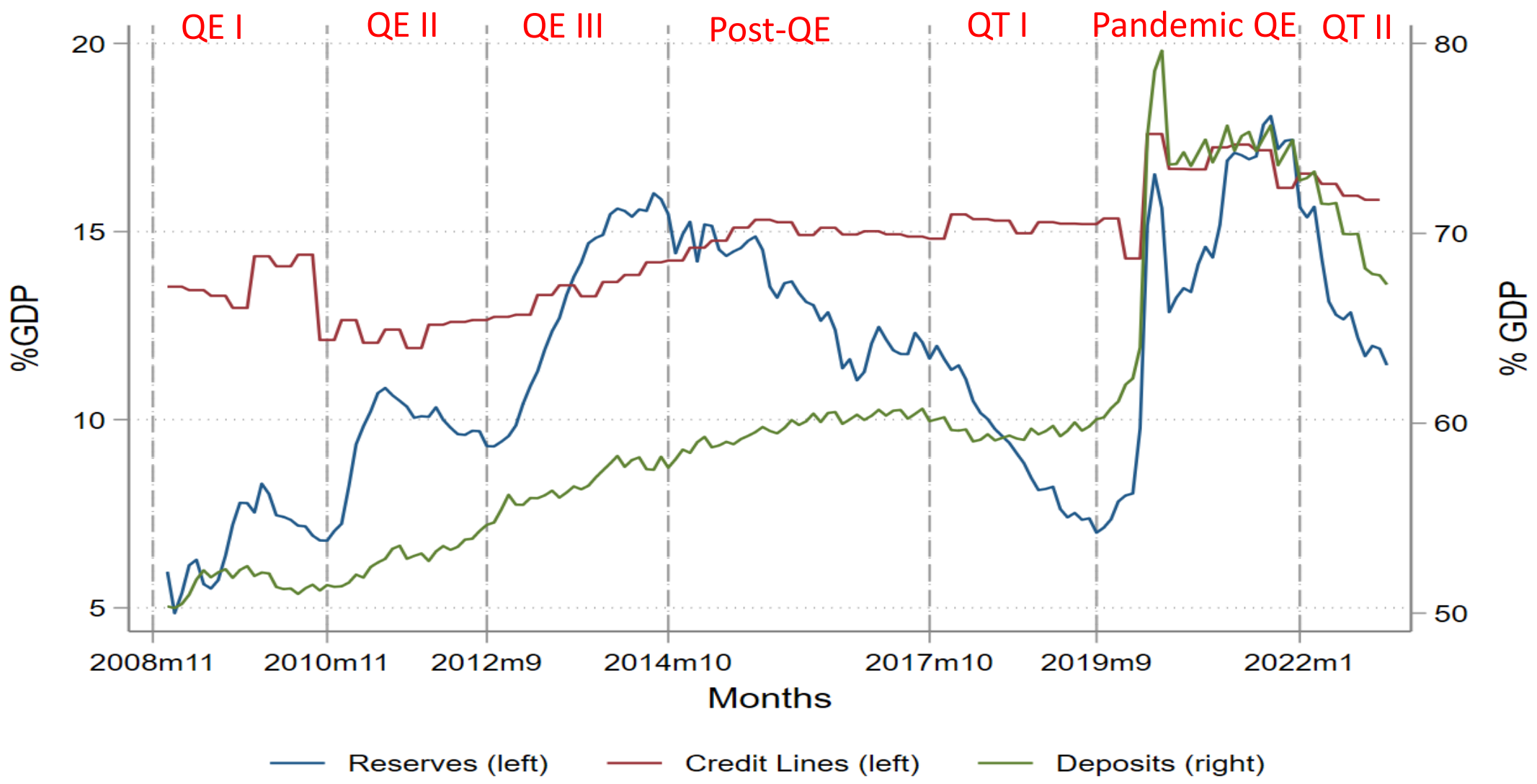
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2008m11
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Months
Reserves (left)
Credit Lines (left)
Deposits (right)

Firm Balance Sheet at Date 0

Assets	Liabilities
I_0	L_0^F
D_0^F	W_0^F
	Net worth

Bank Balance Sheet at Date 0

Assets	Liabilities
$L_0^B + \frac{1}{2}\lambda(L_0^B)^2$	D_0
S_0	e_0
	Net worth

→ Will run to "safe" banks if stressed

Firm Balance Sheet at Date 1 if stressed

Assets	Liabilities
→ I_1	l_1^F
	L_0^F
	Net worth

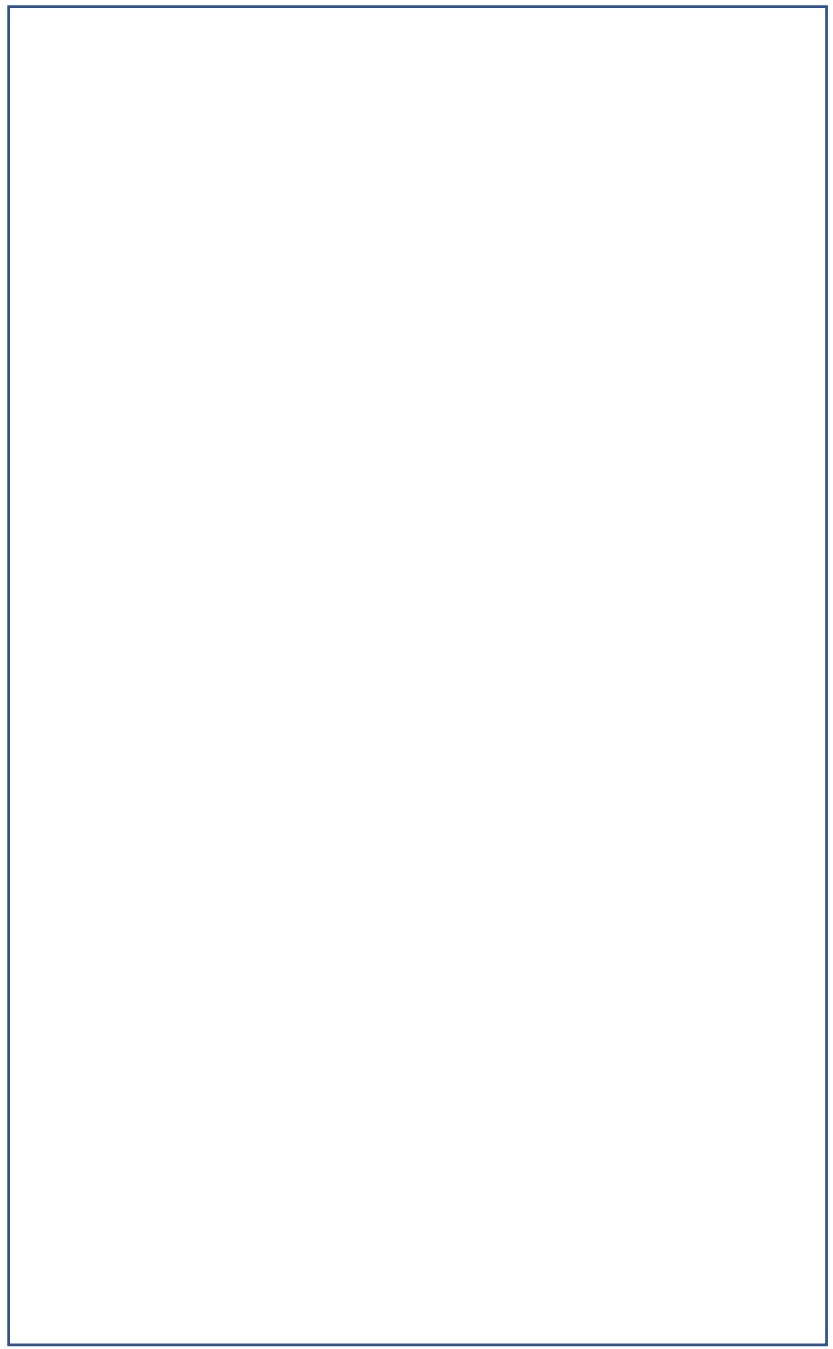
Rescue investment, Redeposited In "safe" banks

Bank Balance Sheet at Date 1 if bank stressed

Assets	Liabilities
$L_0^B + \frac{1}{2}\lambda(L_0^B)^2$	Possible interbank borrowing = b_1
→ τS_0	e_1
$l_1^B \quad (= l_1^F)$	e_0
	Net worth

Shrinkage or Encumbrance on reserves

Liquidity Demand at date 1



Bank Balance Sheet at Date 0	
Assets	**Liabilities**
$L_0^B + \frac{1}{2}\lambda(L_0^B)^2$	D_0
S_0	e_0
	Net worth

Bank Balance Sheet at Date 1 if bank healthy, economy stressed	
Assets	**Liabilities**
$L_0^B + \frac{1}{2}\lambda(L_0^B)^2$	D_0
Interbank loans of up to $e_1 + (1-\tau)S_0$	e_1
Reserves of ($S_0 + e_1$ -interbank loans)	e_0
	Net worth

Liquidity Supply

Available reserves

"Tainted" Bank

Price of Liquidity = Supply of Reserves vs. Exogenous demand for liquidity

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