

Balance Sheet Policy Above the ELB

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ECB Forum on Central Banking, June 2023

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Question: What should central banks do with their balance sheets when $r > \text{ELB}$?

When the **policy rate is above the effective lower bound**:

- Monetary policy stance can be adjusted **up/down via interest rate on reserves**
- Balance sheet **not needed** to steer economy

→ How should a central bank choose **balance sheet size** and **asset mix**?

This paper: **Convenience yields** are useful for guiding these choices

- Convenience yields: Benefits on an investment **over-and-above interest and principal payments**
 - From **liquidity**: Saved transactions cost
 - From **safety**: Saved information costs due to low default risk
- Central bank reserves: Liquid and safe asset → Supplying **reserves adds value to the economy** (like cash does)

Question: What should central banks do with their balance sheets when $r > \text{ELB}$?

Derive “convenience-maximizing” reserve supply: Depends on *how* a central bank supplies reserves – asset mix

(a) If reserves are supplied via central bank holdings of assets **without convenience yields**:

Convenience-maximizing reserve supply is **larger**

(b) If reserves are supplied via central bank holdings of assets **with convenience yields** (Treasuries or Bunds):

Convenience-maximizing reserve supply is **smaller**

Steps

1. **Political constraints on asset choice:** Federal Reserve versus ECB
2. **Reminder:** Too many tools above the ELB
3. **Relevant factors:** For choosing balance sheet size and composition above the ELB
4. **Framework:** Derive **convenience-maximizing reserve supply** as a function of **central bank asset choice**
5. **Empirics:** Estimate convenience-maximizing reserves supply for **US** and **euro area**

1. Political constraints on asset choices: Federal Reserve versus ECB

Federal Reserve: Has announced plans to primarily hold **Treasuries** in the longer run “**thereby minimizing the effect of Federal Reserve holdings on the allocation of credit across sectors** of the economy”

- Federal Reserve Act: Fed can hold assets that are **direct obligations of, or guaranteed by, the United States**
 - Corporate bond purchases during COVID crisis: Emergency lending program under Section 13-3
 - Discount window priced to be used mainly in crisis

- Broaddus and Goodfriend (2001): Express common sentiment in US that Fed should mainly hold Treasuries

*“...the Fed’s asset acquisition policy ought to give priority to **preserving public support for the Fed’s independence** by insulating the central bank as much as possible from potentially damaging **disputes regarding credit allocation**”*

*“When the Fed purchases Treasury securities, it [...] **leaves all the fiscal decisions to Congress and the Treasury**”*

1. Political constraints on asset choices: Federal Reserve versus ECB

ECB: Could likely hold only assets without convenience yields in the longer run

- Historically supplied reserves via **collateralized lending to banks**
- **Government bond purchases: Politically sensitive.** Challenged in court
- Schnabel (2023a) states:

*“In the **euro area**, however, there are [...] additional considerations relevant for the assessment of **whether a large bond portfolio is desirable** or not. One is that the **lack of a consolidated public sector balance sheet** raises more **fundamental concerns about monetary and fiscal interactions in a currency union with sovereign member states.** These concerns may potentially **undermine the credibility and independence** of the central bank.”*

1. Political constraints on asset choices: Federal Reserve versus ECB

Across the Atlantic: **What is politically sensitive differs**

- Government bonds:
 - Politically safe choice in US
 - Politically risky choice in euro area
- From the perspective of **convenience-maximization**:
 - ECB is at an advantage: Fits case (a) better
 - Fed is at a disadvantage: Fits case (b) better, given the convenience yield on Treasuries

2. Reminder: Too many tools above the ELB

Lopez-Salido and Vissing-Jorgensen (2023):

1. Reserves pay interest, *IOR*
2. Reserves have **liquidity benefits** for banks: Don't have to sell illiquid assets if deposits drop

$v(\text{Reserves}, \text{Deposits})$	Convenience value: Expected transaction costs savings from (excess) reserves
$v'_R(\text{Reserves}, \text{Deposits})$	Convenience yield: Marginal value of more reserves Decreasing in reserves, increasing in deposits

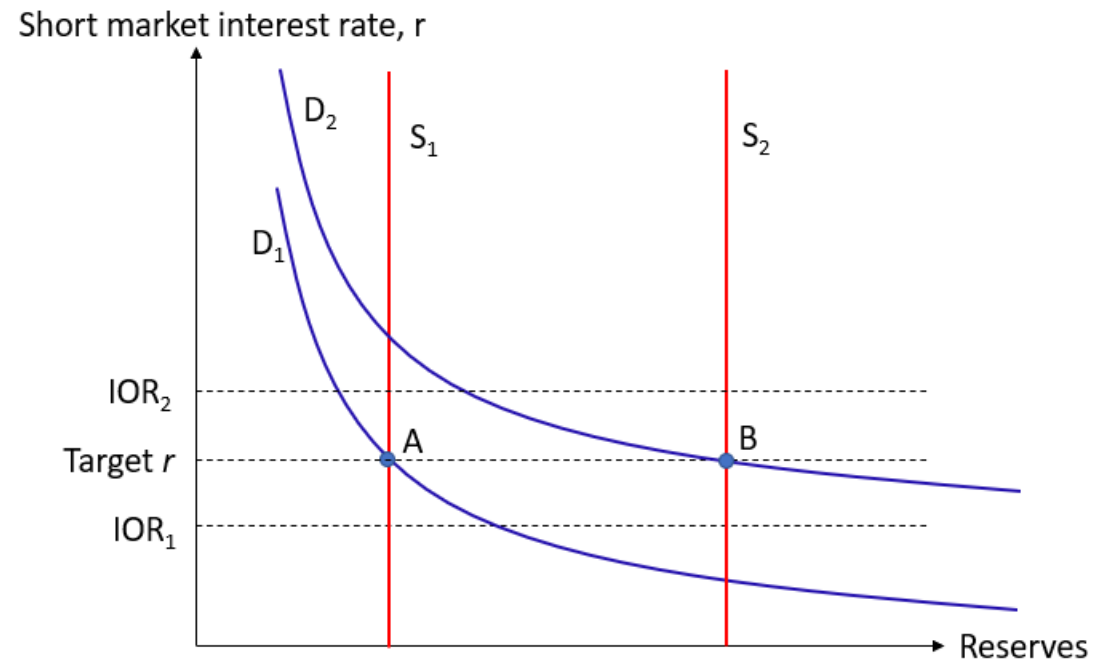
3. **Bank balance sheet cost φ** per dollar of assets (capital requirements, e.g., Supplementary Leverage Ratio)

→ Banks' **first-order condition** for borrowing at market rate r and investing in reserves:

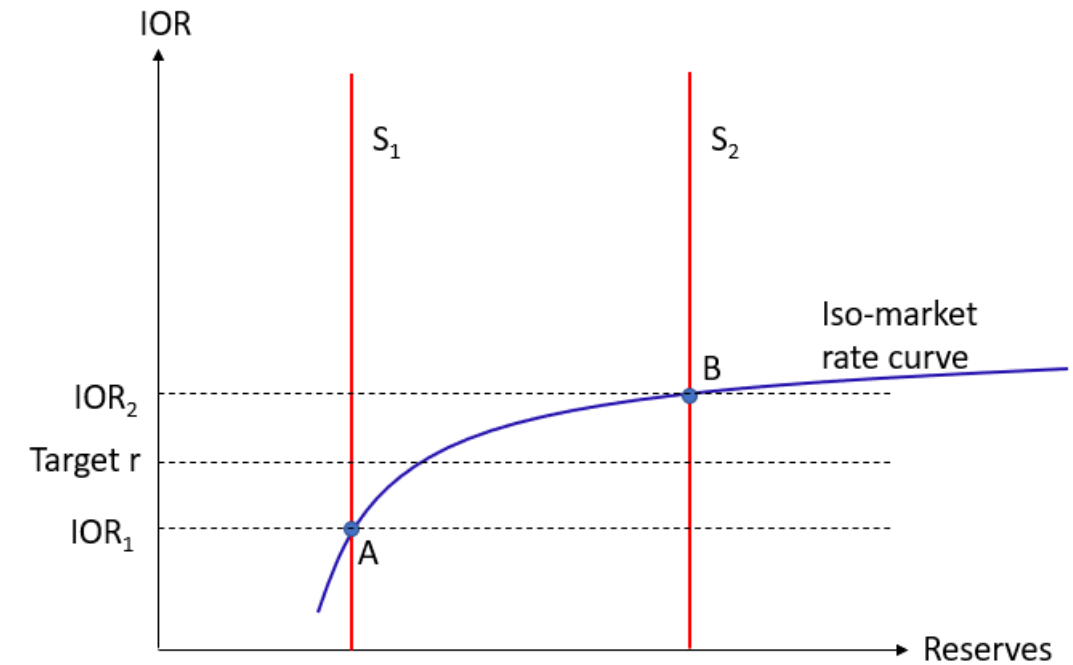
$$\underbrace{r}_{\substack{\text{Highest interest rate} \\ \text{bank is willing to pay} \\ \text{to borrow to invest in reserves}}} = \underbrace{IOR + v'_R(\text{Reserves}, \text{Deposits}) - \varphi}_{\text{Net benefit of reserves}} \quad \text{Reserve demand curve}$$

2. Reminder: Too many tools above the ELB

Reserve market



Iso-market rate curve for short rate



Reserve demand: $r = IOR + v'_R(Reserves, Deposits) - \varphi$ Shifts with IOR , φ . $v'_R(\cdot) \downarrow$ in reserves (eventually to 0)

- A: Low IOR, $IOR_1 \rightarrow$ To hit target, need $v'_R(\cdot) - \varphi > 0 \rightarrow$ Need low reserve supply, S_1
- B: High IOR, $IOR_2 \rightarrow$ To hit target, need $v'_R(\cdot) - \varphi < 0 \rightarrow$ Need high reserve supply, S_2

“Iso-market rate” curve: $(IOR, Reserves)$ combinations that achieve same target

- How to set balance sheet size given the IOR, or conversely
- Iso-market rate curve for long market rate: Steeper

3. Factors relevant for choosing balance sheet size and composition above the ELB

(a) *Central bank's liquidity/safety supply*: My focus here

(b) *Side effects of large central bank balance sheets*: Banks need to **fund their reserve holdings**

- **Crowding-out** of bank securities holdings/loans: Can lead to a welfare loss
- **Crowding-in** of deposits/other liabilities: Beneficial if they provide liquidity/safety benefits but add to financial stability risk

(c) *Interest rate volatility*:

- **Reserve demand flatter at higher quantities** → Less interest rate volatility from volatility in central bank **autonomous factors** (currency, government deposits) and associated **reserve supply volatility**

(d) *Central bank profits*:

- CB losses may pose a **threat to central bank independence**
→ Large current balance sheet may **limit headroom for future QE** if needed (e.g., Hauser (2022))

Suggestion: Start from my numbers, add/subtract based on your policy preferences regarding the other factors

4. Framework: Convenience-maximizing reserve supply and asset choice

Friedman rule for **optimal supply of money** (non-interest bearing):

- Maximize welfare from money: Set convenience yield **on money to zero**

Translated to **optimal supply of reserves** (interest bearing):

- Maximize welfare from reserves: Set convenience yield **on reserves (net of φ) to zero**

Fed: “Lowest Comfortable Level of Reserves” (LCLoR)

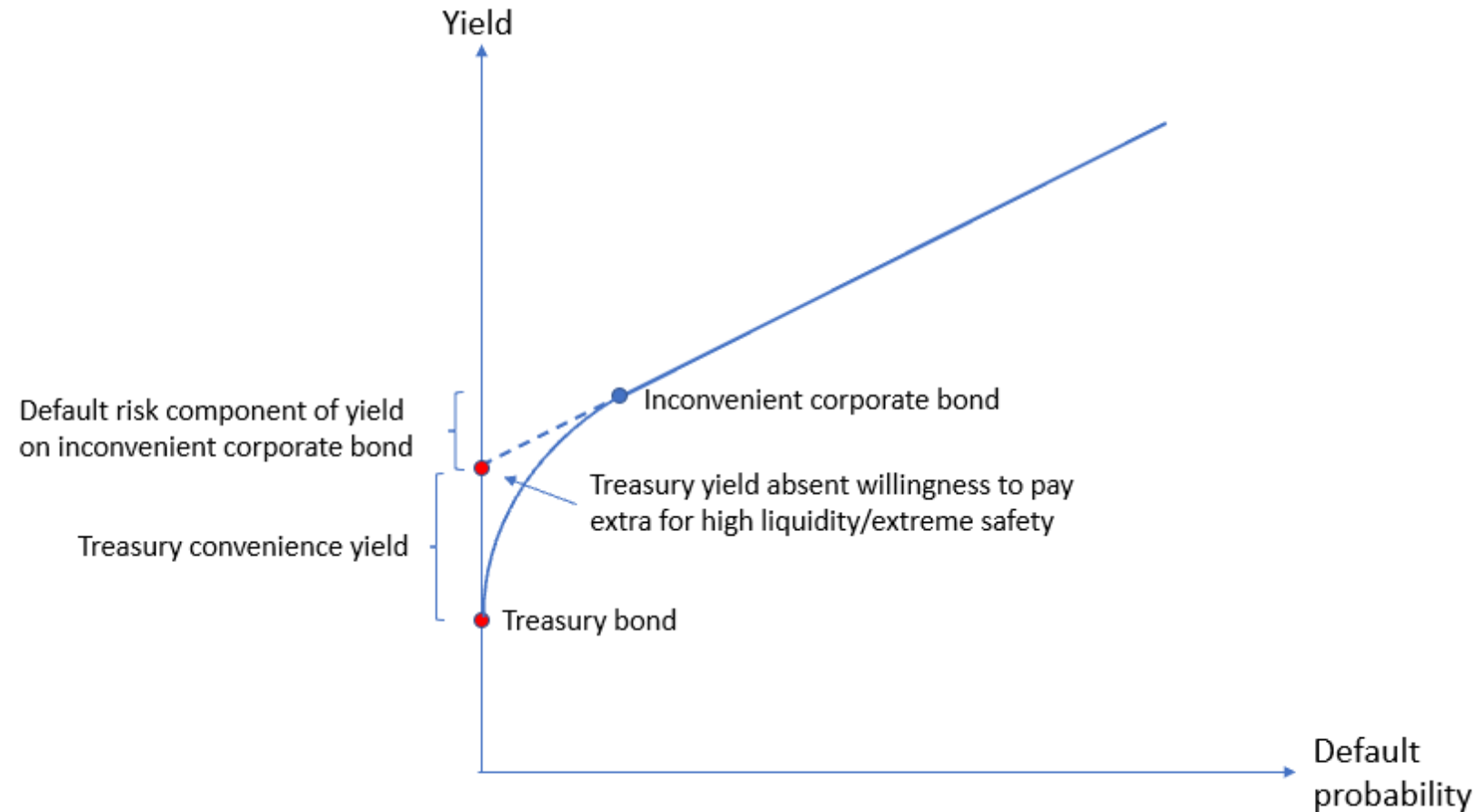
ECB: “Floor Required Excess Liquidity” (FREL)

BoE: “Preferred Minimum Range of Reserves” (PMRR)

- Useful, but what if the CB’s **assets** have a convenience yield too? (From liquidity/safety, will not matter)

4. Framework: Convenience-maximizing reserve supply and asset choice

Convenience yields on bonds – illustration for Treasuries (works the same for Bunds)



- Yields on **very safe** assets, which also tend to be **very liquid**:
Below “normal” yield-risk relation
- $y^{Inconv. corp. bonds} - y^{Treasury}$
 $= \underbrace{v'_T(T)}_{\text{Treasury conv. yield}} + \underbrace{\text{Default component}}_{\text{Spread for large Treasury supply}}$
- Krishnamurthy and Vissing-Jorgensen (2012):
Avg. (long) Treasury conv. yield, 1919-2008
 - **46 bps** relative to Aaa corporate bonds
 - **73 bps** relative to Baa corporate bonds

4. Framework: Convenience-maximizing reserve supply and asset choice

Trading off convenience yields on reserves and asset holdings

Central bank's balance sheet:

$$\underbrace{B^{cb}}_{\text{CB holdings of bonds w/convenience yield}} = \underbrace{R}_{\text{Reserves}} + \underbrace{A}_{\text{Autonomous factors}} \quad (1)$$

Private sector convenience from reserves and bonds:

$$[v_R(R) - \varphi R] + v_B(B - B^{cb}) \quad (2)$$

- **Is bank balance sheet cost φ a social cost? Yes**
 - Banks' perspective: φ is due to capital requirements
 - Society's perspective: Capital req's imposed due to short-term debt externality, Stein (2012)
 - If capital req. set optimally: We should subtract φ in convenience-maximization

4. Framework: Convenience-maximizing reserve supply and asset choice

$$[v_R(R) - \varphi R] + v_B(B - R - A)$$

Result (Convenience-maximizing reserve supply).

(a) If a central bank holds assets *without convenience yields*:

$$\text{Max}_R v_R(R) - \varphi R$$

→ Conv. maximizing supply of central bank reserves, $R^{C(a)}$, solves: $v'_R(R) - \varphi = 0$

(b) If the central bank holds bonds (B) *with convenience yields*:

$$\text{Max}_R [v_R(R) - \varphi R] + v_B(B - R - A)$$

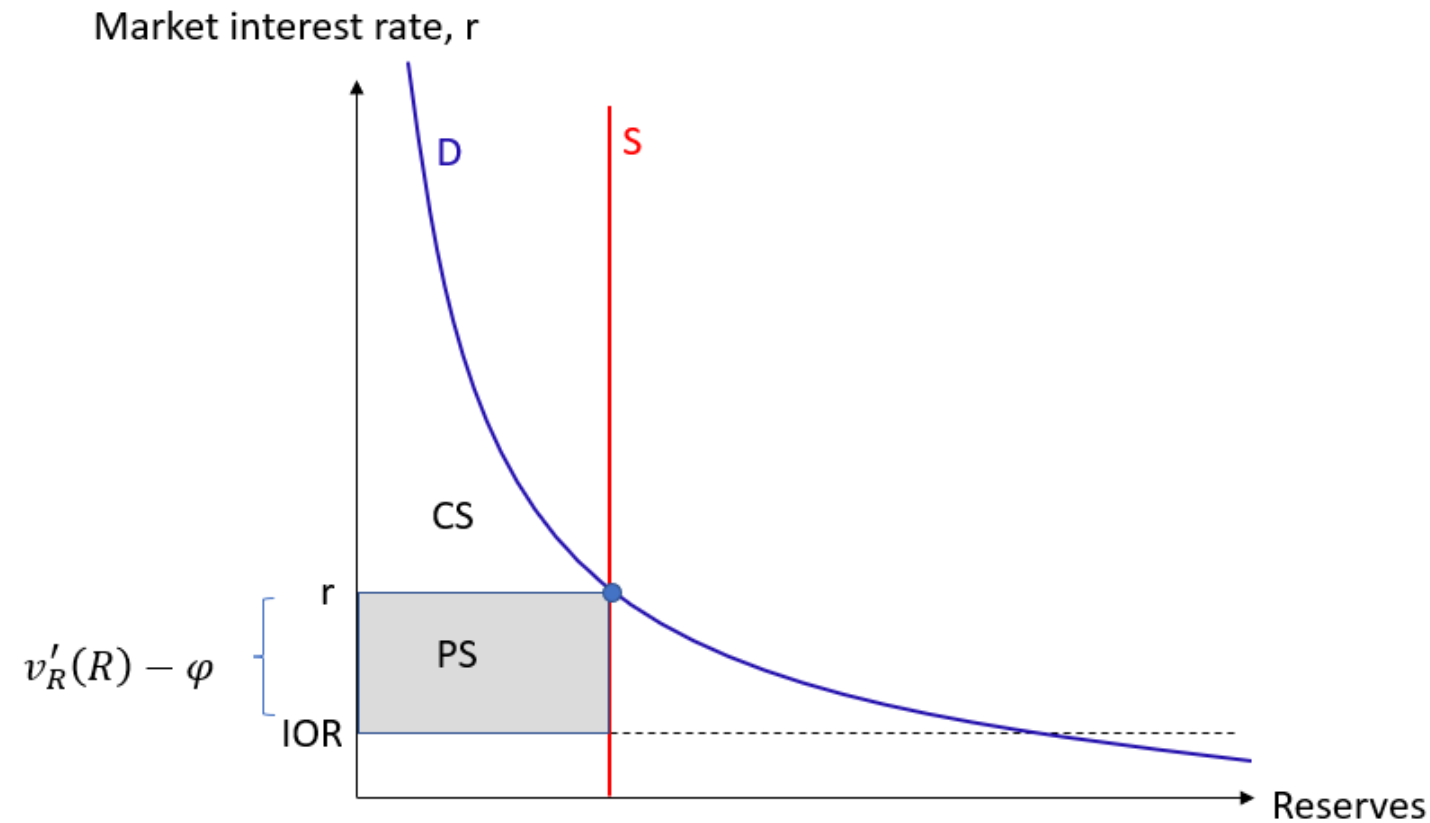
→ Conv. maximizing supply of central bank reserves, $R^{C(b)}$, solves: $v'_R(R) - \varphi = v'_B(B - R - A)$

(Paper: This result holds regardless of the exact mix of crowding out/in that banks use to fund reserves)

4. Framework: Convenience-maximizing reserve supply if CB holds “inconvenient” assets

Case (a)

Reserve market



Total convenience value of reserves:

- Area between reserve demand curve and IOR

- For given unit of reserves

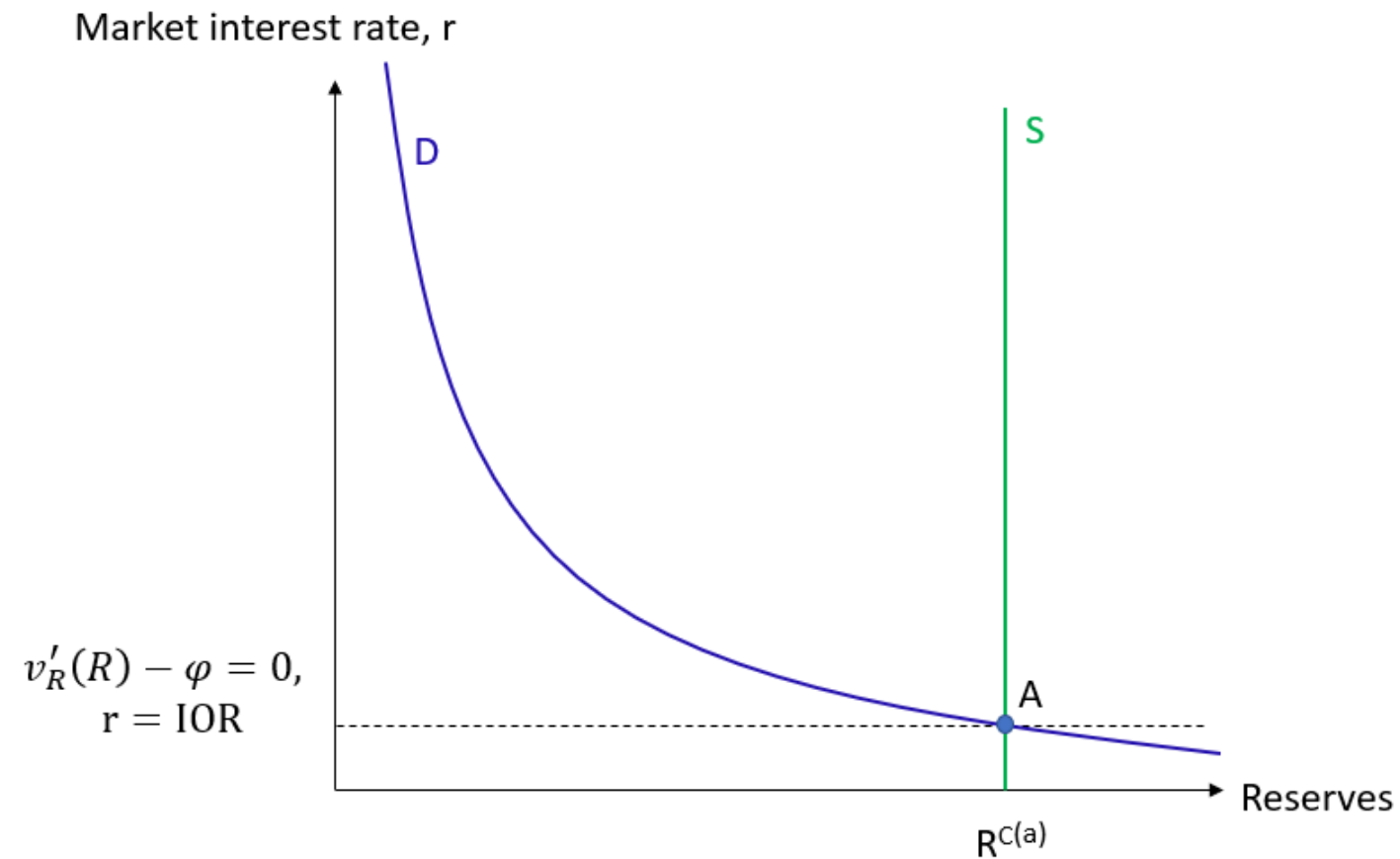
Consumers' surplus (CS): $[IOR + v'_R(R) - \varphi] - r$

Producers' surplus (PS): $r - IOR$

Sum: $v'_R(R) - \varphi$

4. Framework: Convenience-maximizing reserve supply if CB holds “inconvenient” assets

Reserve market



Convenience-maximizing reserve supply:

- $R^{C(a)}$ maximizes CS+PS by setting $v'_R(R) - \varphi = 0$

4. Framework: Convenience-maximizing reserve supply if CB holds "convenient" assets

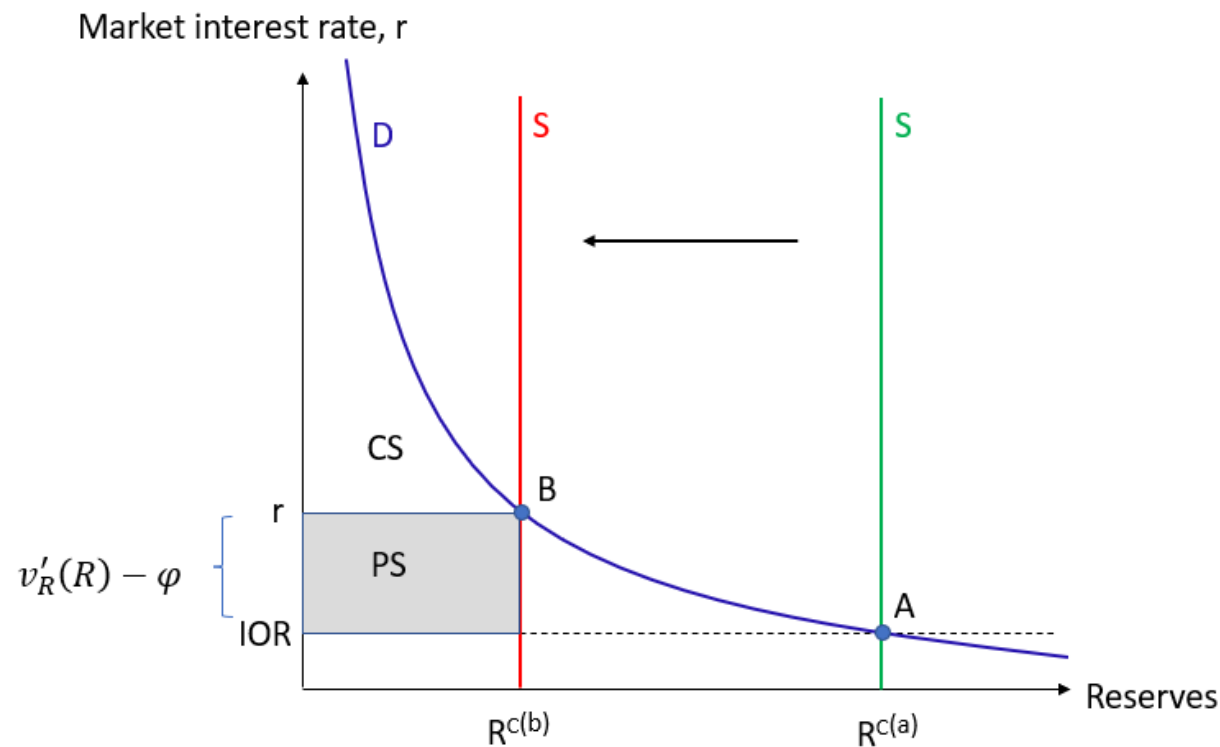
Case (b)

Reserve market

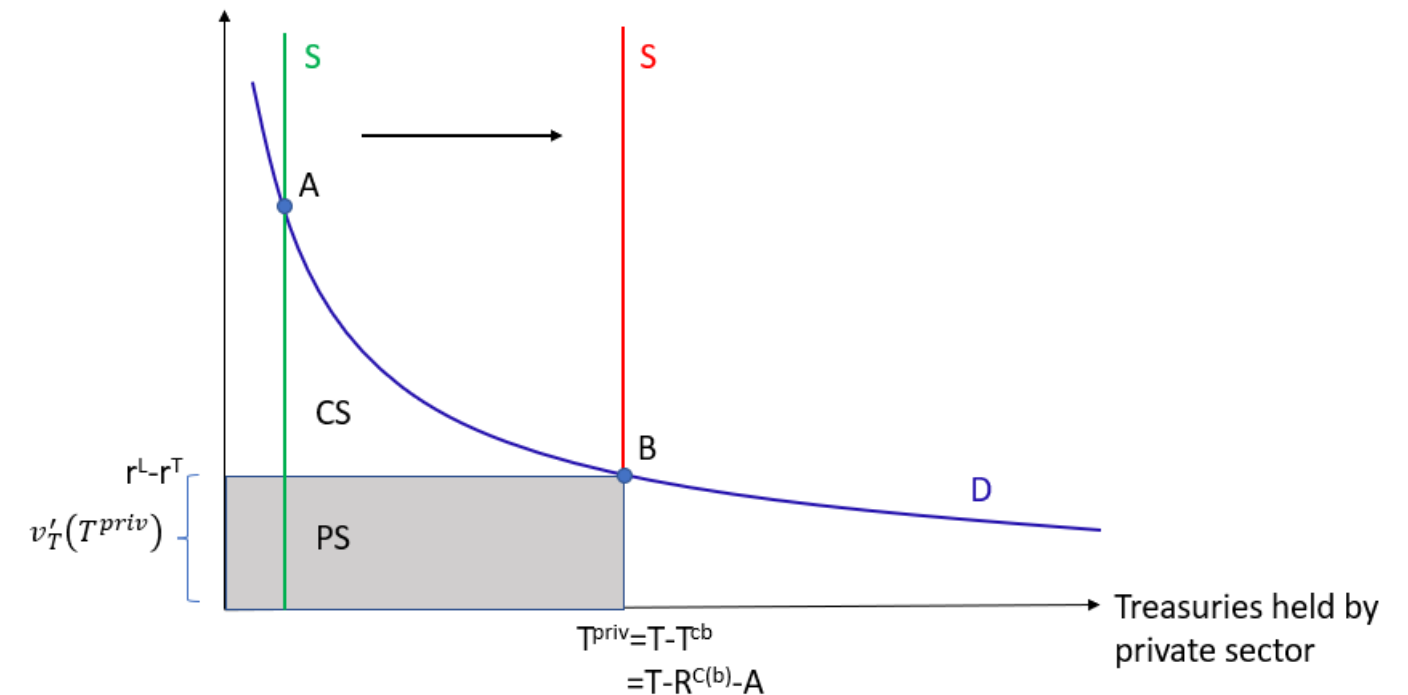
$$D: [IOR + v'_R(R) - \varphi]$$

Bond market (e.g., Treasuries)

$$D: v'_T(T^{priv})$$



[Market interest rate (inconv.), r^L] - [Treasury yield, r^T]



- $R^{C(b)}$ maximizes total conv. value (CS+PS) from both reserves and bonds: Set $v'_R(R) - \varphi = v'_T(T^{priv})$

4. Framework: Convenience-maximizing reserve supply and asset choice

COMMENT. What if the ECB decided to supply reserves with a mix of bank lending (inconvenient) and government bonds (some of which convenient)?

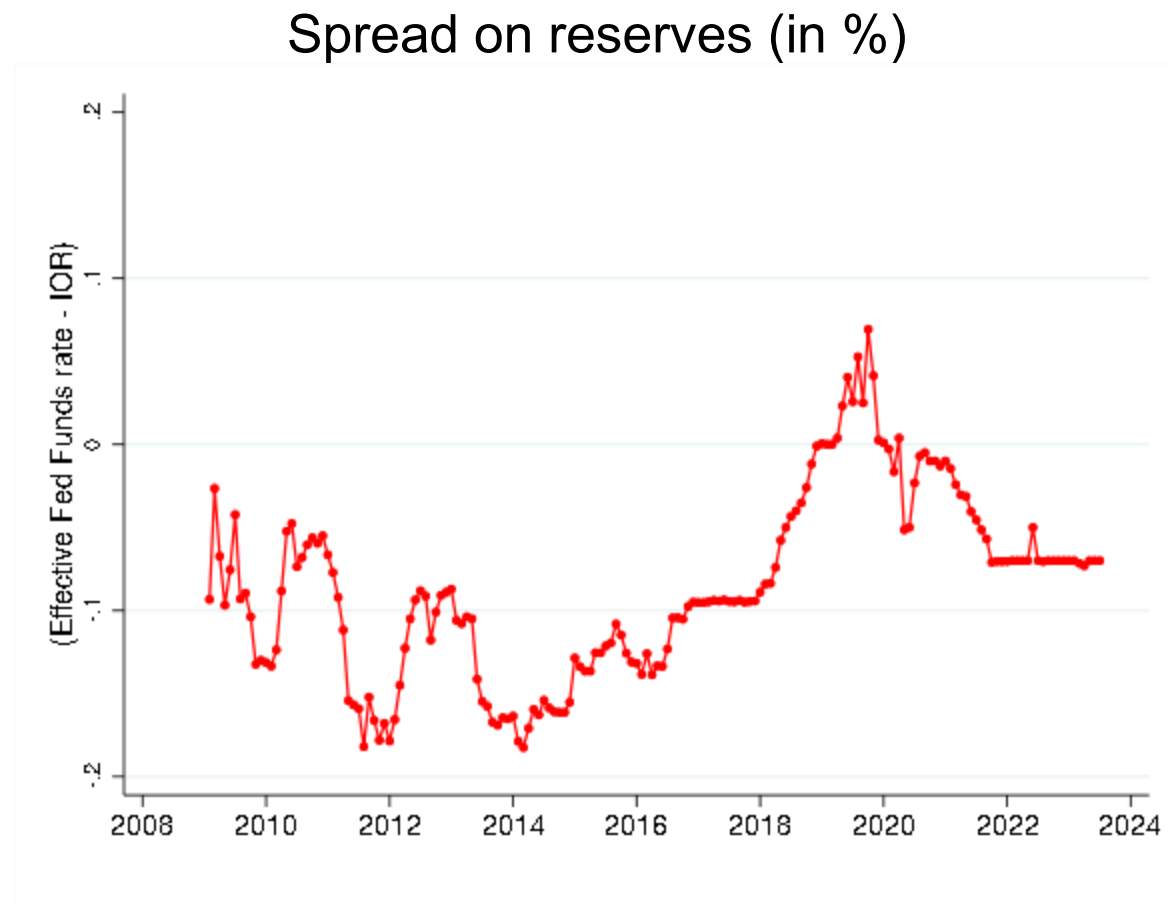
- Set $v'_R(R) - \varphi = \text{Average convenience yield on ECB assets}$
- Suppose only German bunds have convenience yield

$$v'_R(R) - \varphi = \underbrace{v'_B(B_1^{priv})}_{\text{Convenience yield on bunds}} * \underbrace{\omega}_{\text{ECB portfolio weight on bunds}} * \underbrace{\alpha_1}_{\text{Weight of bunds in ECB's government bond portfolio}}$$

5. Estimating the convenience-maximizing reserve supply for the US

Yield spreads on reserves (relative to inconvenient assets)

Monthly data, 2009M1-2023M4



- Use effective federal funds rate for short market rate
- $\text{EFFR} - \text{IOR} (= v'_R(\cdot) - \varphi)$
 - April 2023: $v'_R(\cdot) - \varphi$ around -7 bps

5. Estimating the convenience-maximizing reserve supply for the US

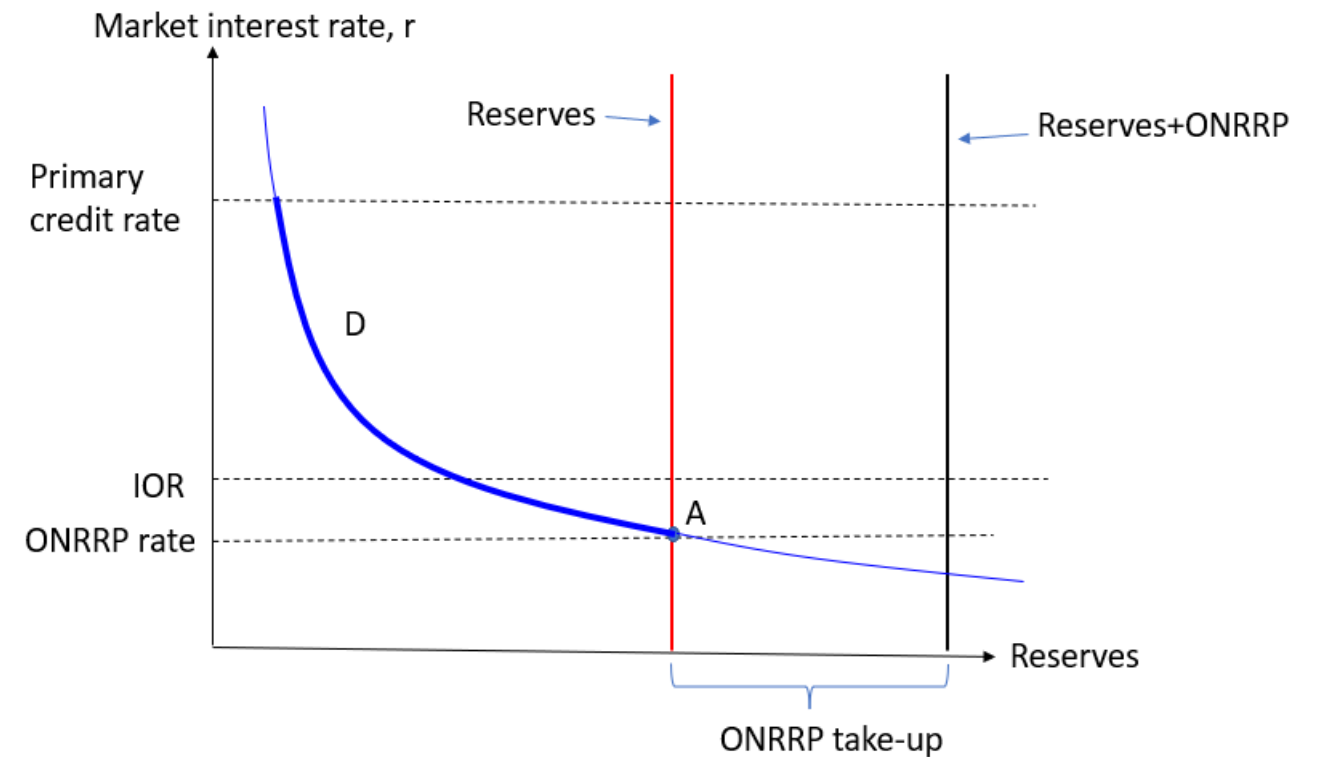
Estimating reserve demand: Lopez-Salido and Vissing-Jorgensen (2023)

- $v'_R(\cdot) - \varphi$ **log-linear** in (excess) reserves and deposits. Demand shock, u

$$v'_R(\text{Reserves}, \text{Deposits}) - \varphi = a + b * \ln(\text{Excess Reserves}) + c * \ln(\text{Deposits}) + u$$

$$\text{EFFR} - \text{IOR} = a + b * \ln(\text{Excess Reserves}) + c * \ln(\text{Deposits}) + u$$

- **Instrument excess reserves with Reserves+ONRRP:**
 - Negative u lowers reserves (increases ONRRP)
 - Reserves+ONRRP = Fed Assets-Autonomous factors
Likely uncorrelated with u
- Instrumenting for deposits has little effect on results
 - **Controlling for deposits crucial** to get stable reserve demand function



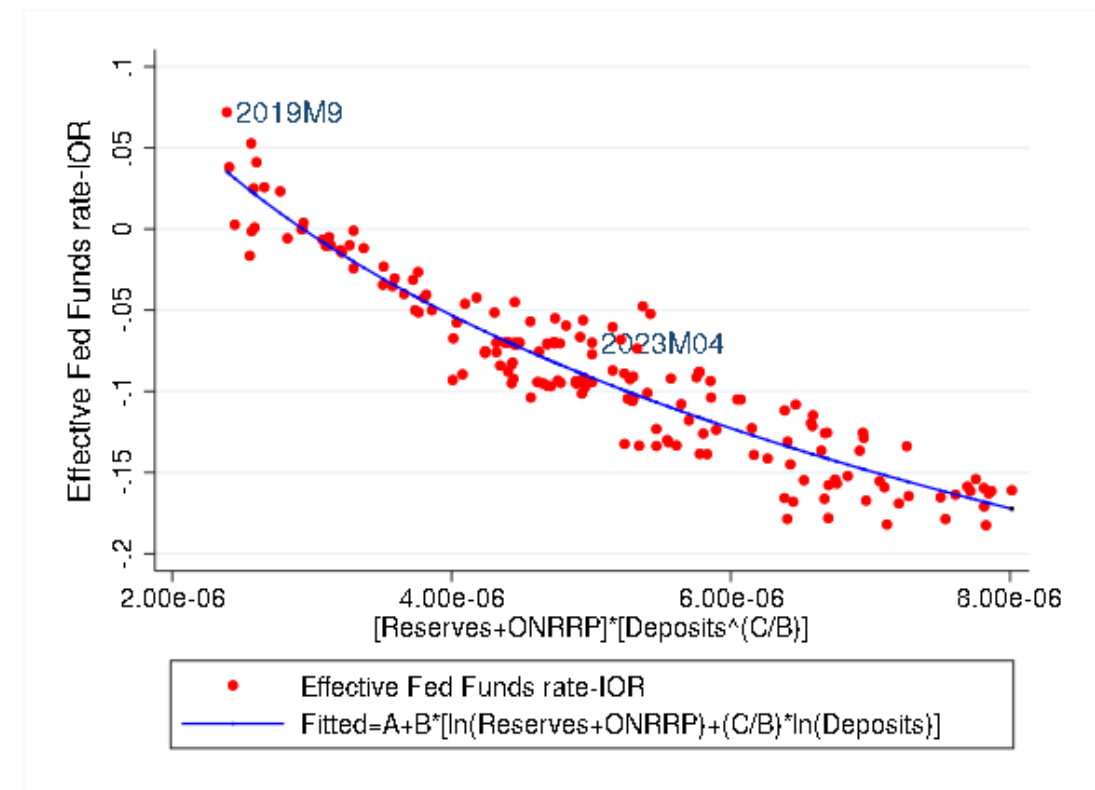
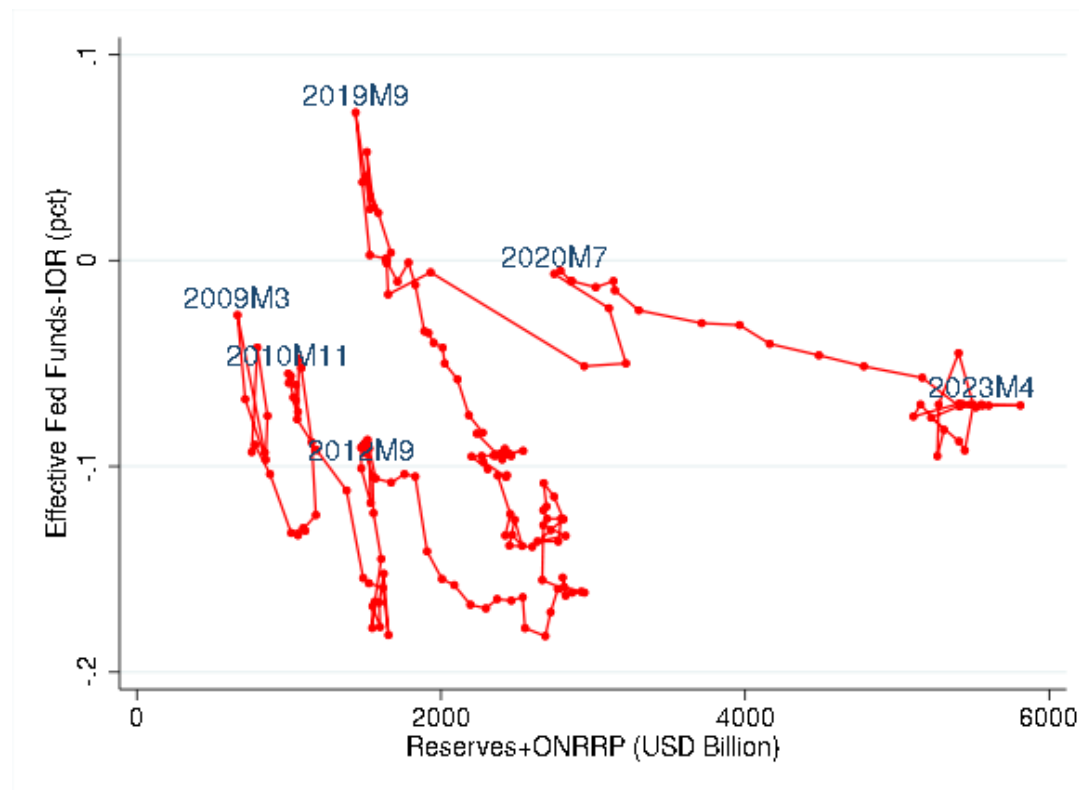
5. Estimating the convenience-maximizing reserve supply for the US

- Reduced form of IV:

$$EFFR - IOR = A_R + B_R * \ln(Reserves + ONRRP) + C_R * \ln(Deposits) + U$$

$$= A_R + B_R * \ln \left[\underbrace{(Reserves + ONRRP) * (Deposits)^{\frac{C_R}{B_R}}}_{\text{Deposit-adjusted Reserves+ONRRP supply}} \right] + U$$

- Monthly data, 2009M1-2023M4

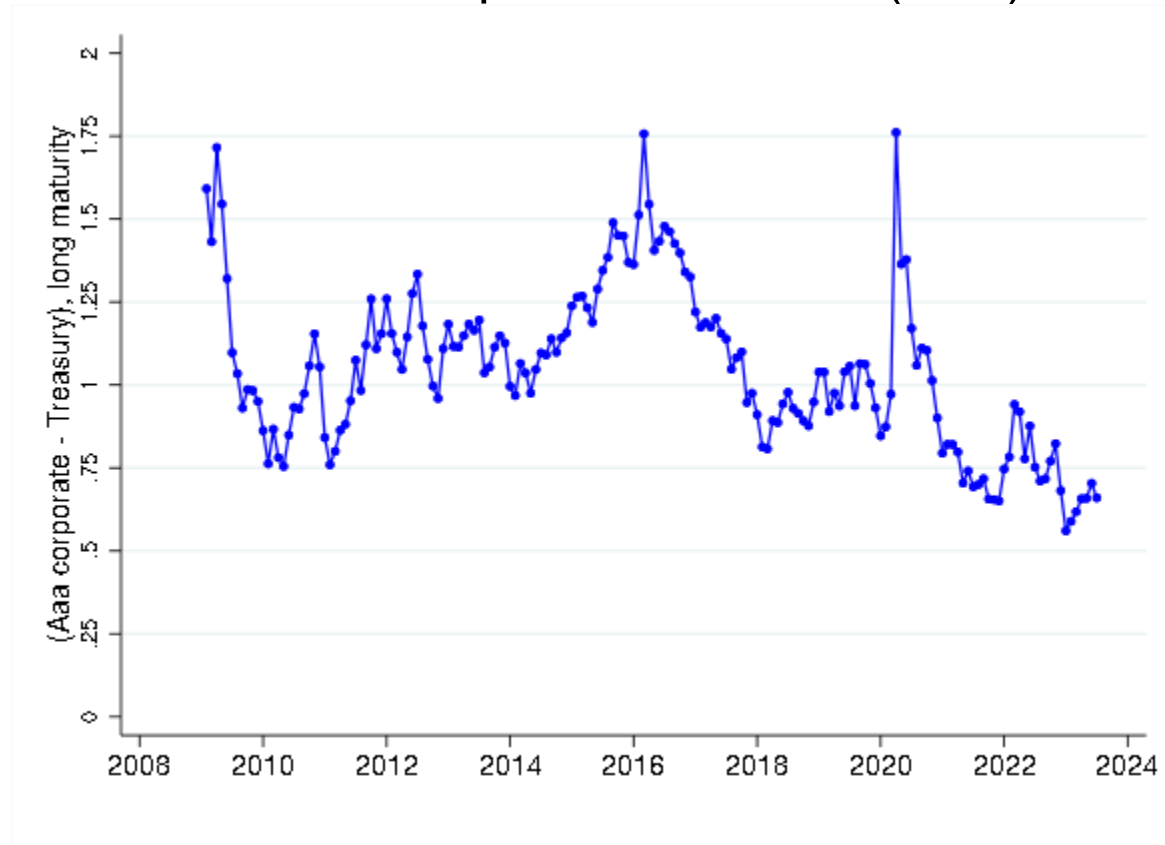


5. Estimating the convenience-maximizing reserve supply for the US

Yield spreads on Treasuries (relative to inconvenient assets)

Monthly data, 2009M1-2023M4

Spreads on Treasuries
relative to corporate securities (in %)

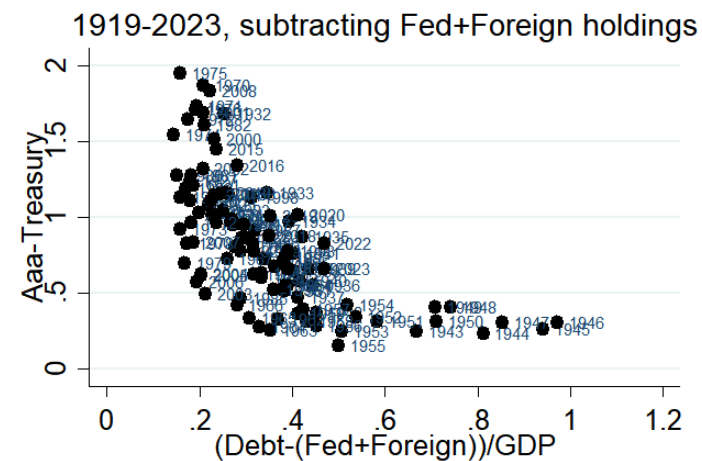
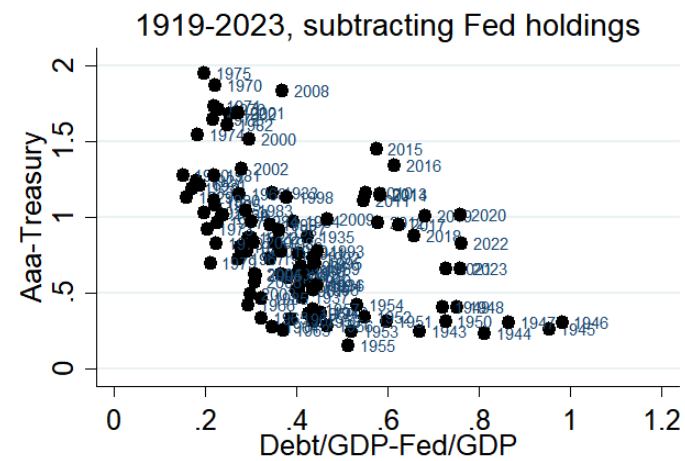
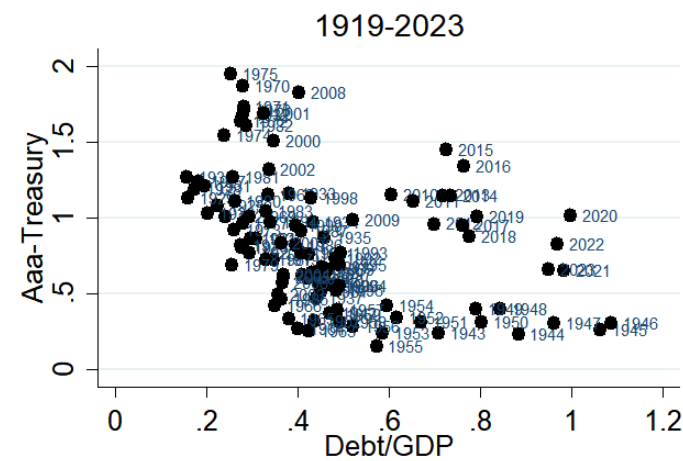
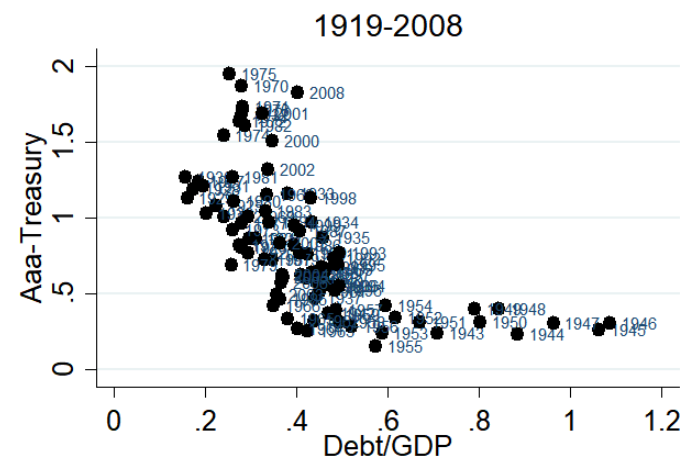


- $y^{Aaa} - y^{Treasury}$: Large across the sample
 - April 2023: **66 bps**
Default component: Around 31 bps
Convenience yield: $v'_T(.)$ around **35 bps**
- Use **Aaa - Treasury spread** (adjusted for default) as measure of **Treasury convenience yield in general**
 - Not much **term structure** to the Treasury convenience yield down to at least 3 years
 - Could use a weighted avg. of Aaa-Treasury & CP-Bill spreads

5. Estimating the convenience-maximizing reserve supply for the US

Estimating Treasury demand: Build on Krishnamurthy and Vissing-Jorgensen (2012)

Annual data, 1919-2023:



- **Top left:** $v'_T\left(\frac{Treasuries}{GDP}\right)$
- **Top right:** Demand shifted right post-GFC

Due to Fed & foreign demand shocks

- **Bottom left:** Role of Fed demand shocks
- **Bottom right:** Role of foreign demand shocks

Convenience-maximization:

- Need $v'_T\left(\frac{Treasuries^{Private}}{GDP}\right)$

5. Estimating the convenience-maximizing reserve supply for the US

Estimating Treasury demand:

- $v'_T\left(\frac{Treasuries^{Private}}{GDP}\right)$ log-linear in Debt/GDP
- Accounting for demand shocks post-GFC and estimating default component as asymptote (C_T):

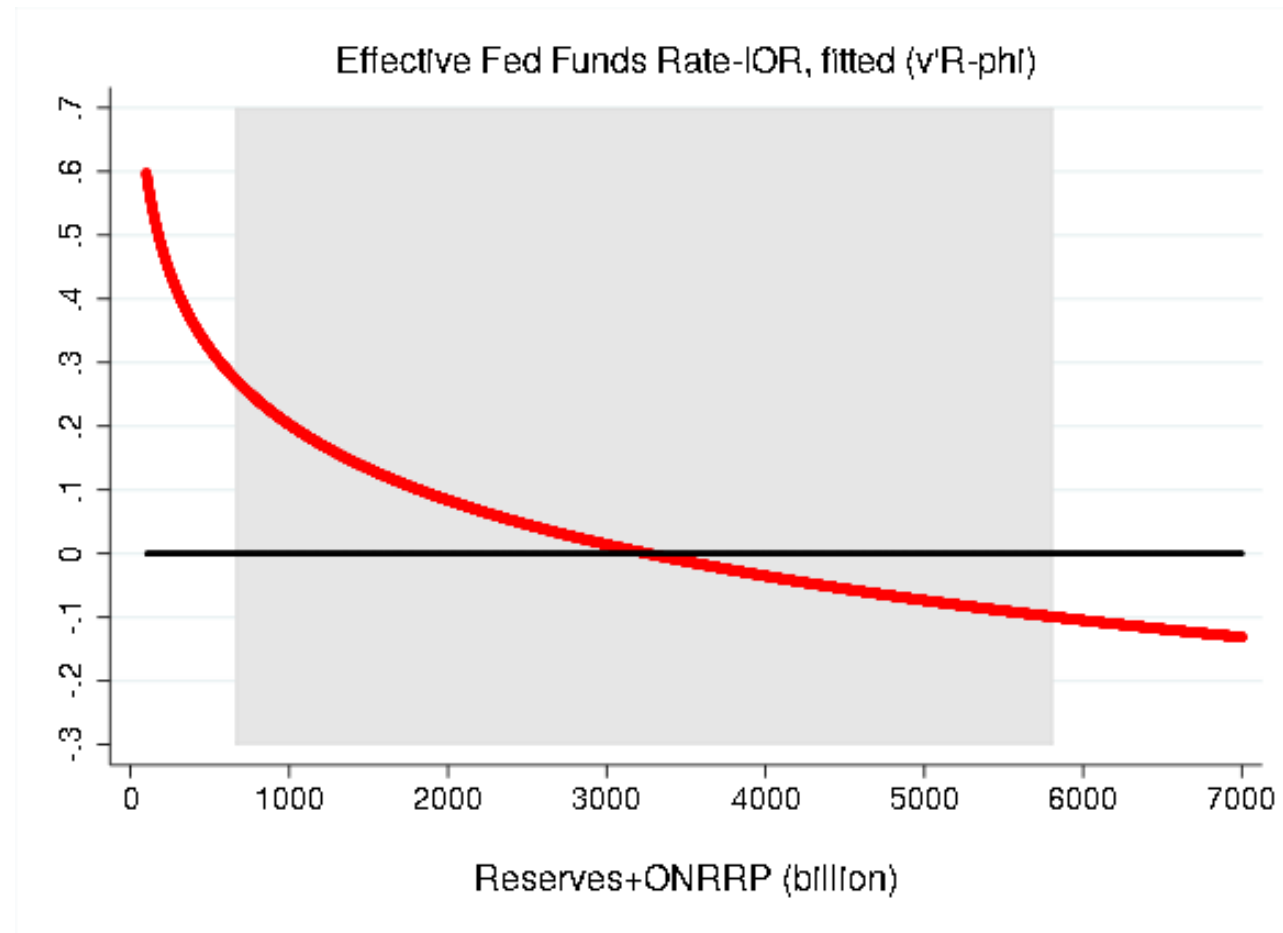
$$y^{Aaa} - y^{Treasury} = \max(A_T + B_T * \ln\left(\frac{Treasuries^{Private}}{GDP}\right) + \sum_{i=2009}^{2023} \beta_i D(year = i), C_T) + U$$

- Annual data, 1919-2023

5. Estimating the convenience-maximizing reserve supply for the US

Case (a): Convenience-maximizing reserve (+ONRRP) supply: Supplied via *inconvenient assets*

April 2023:



Gray shaded area: Range of data used in estimation

$$\bullet v'_R(\cdot) - \phi = \widehat{A}_R + \widehat{B}_R * \ln(\text{Reserves} + \text{ONRRP}) + \widehat{C}_R * \ln(\text{Deposits})$$

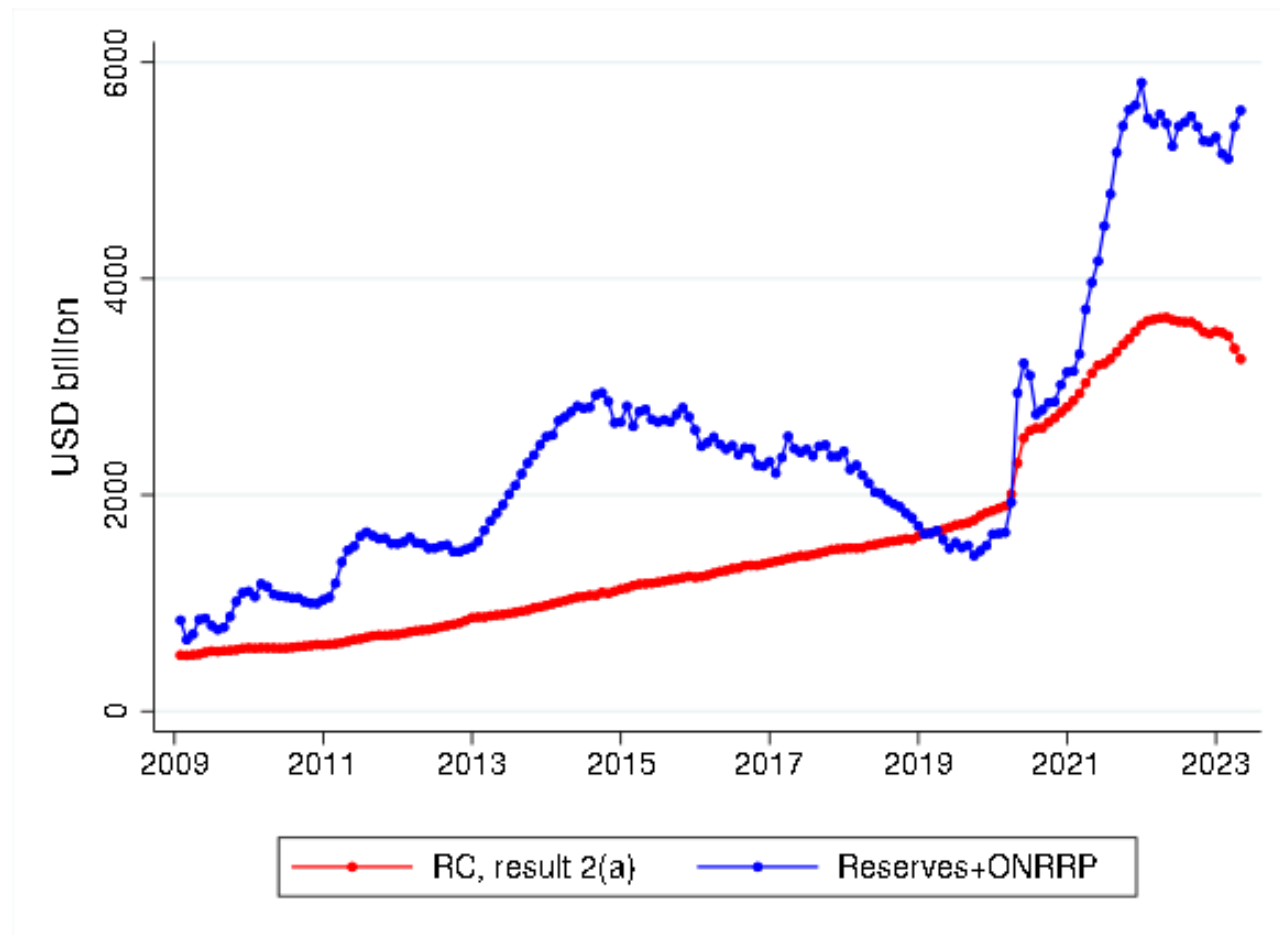
using deposits for April 2023: **\$17.2T**

$$\bullet v'_R(\cdot) - \phi = 0: \text{Reserves+ONRRP} = \mathbf{\$3.257T}$$

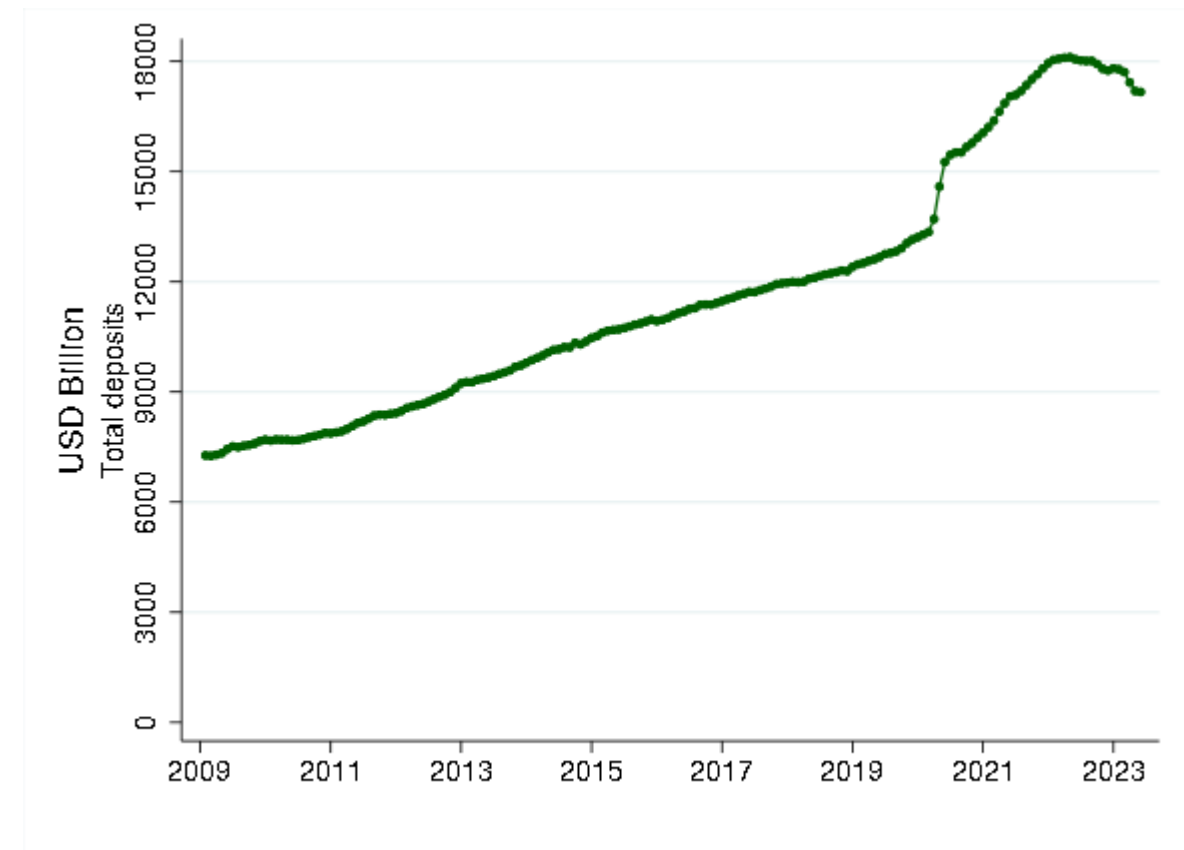
(Current value: \$5.554T)

5. Estimating the convenience-maximizing reserve supply for the US

Conv. max. supply over time



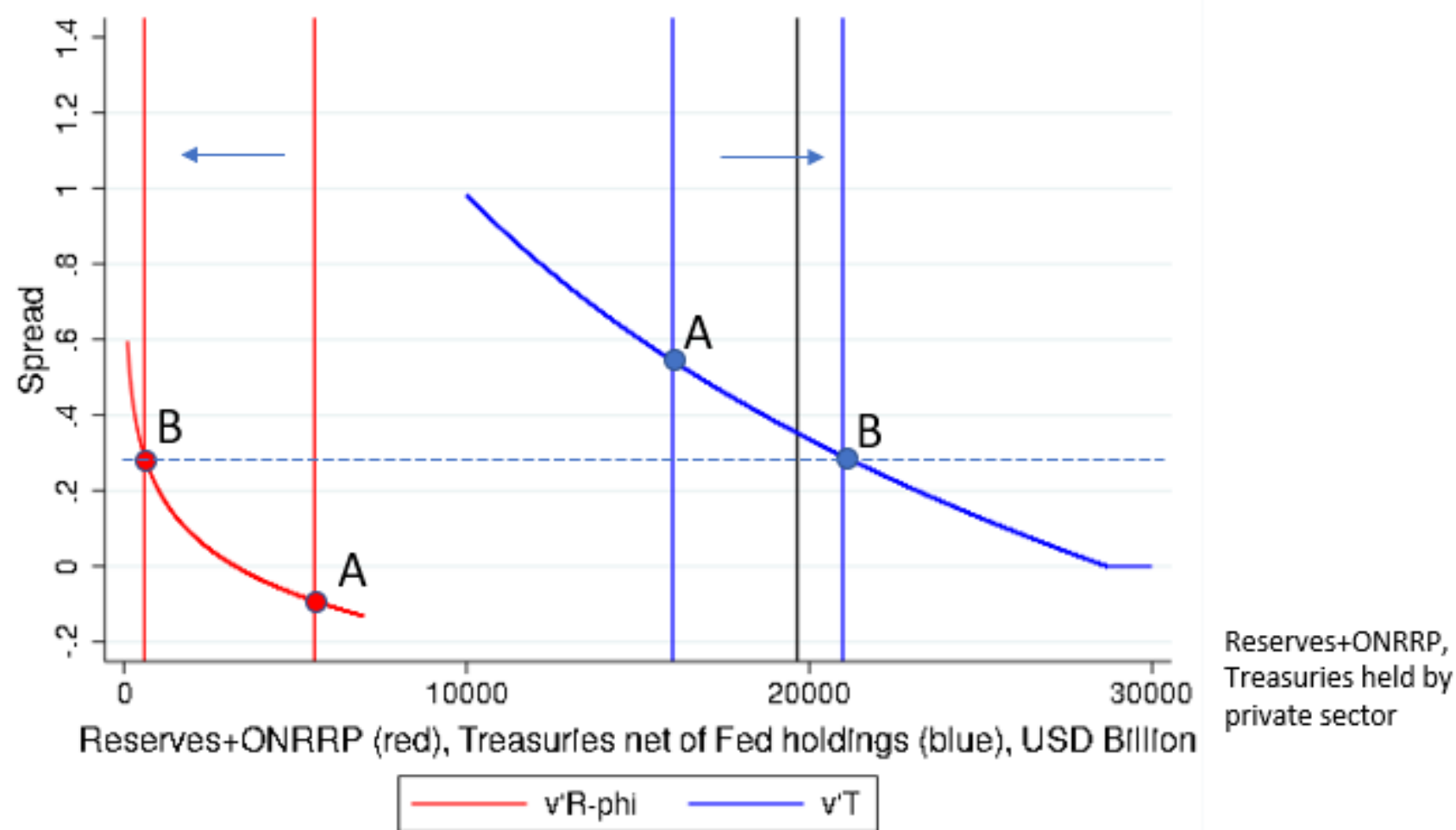
Deposits



5. Estimating the convenience-maximizing reserve supply for the US

Case (b): Convenience-maximizing reserve (+ONRRP) supply: Supplied via Treasury holdings

April 2023:



- **Red:** $v'_R(\cdot) - \varphi$ given current deposits
- **Blue:** $v'_T\left(\frac{Treasuries^{Private}}{GDP}\right)$ given current GDP
- **A:** Locations at **current** Reserves+ONRRP if Fed only held Treasuries
- **B:** Locations at **convenience-maximizing** Reserves+ONRRP if Fed only holds Treasuries

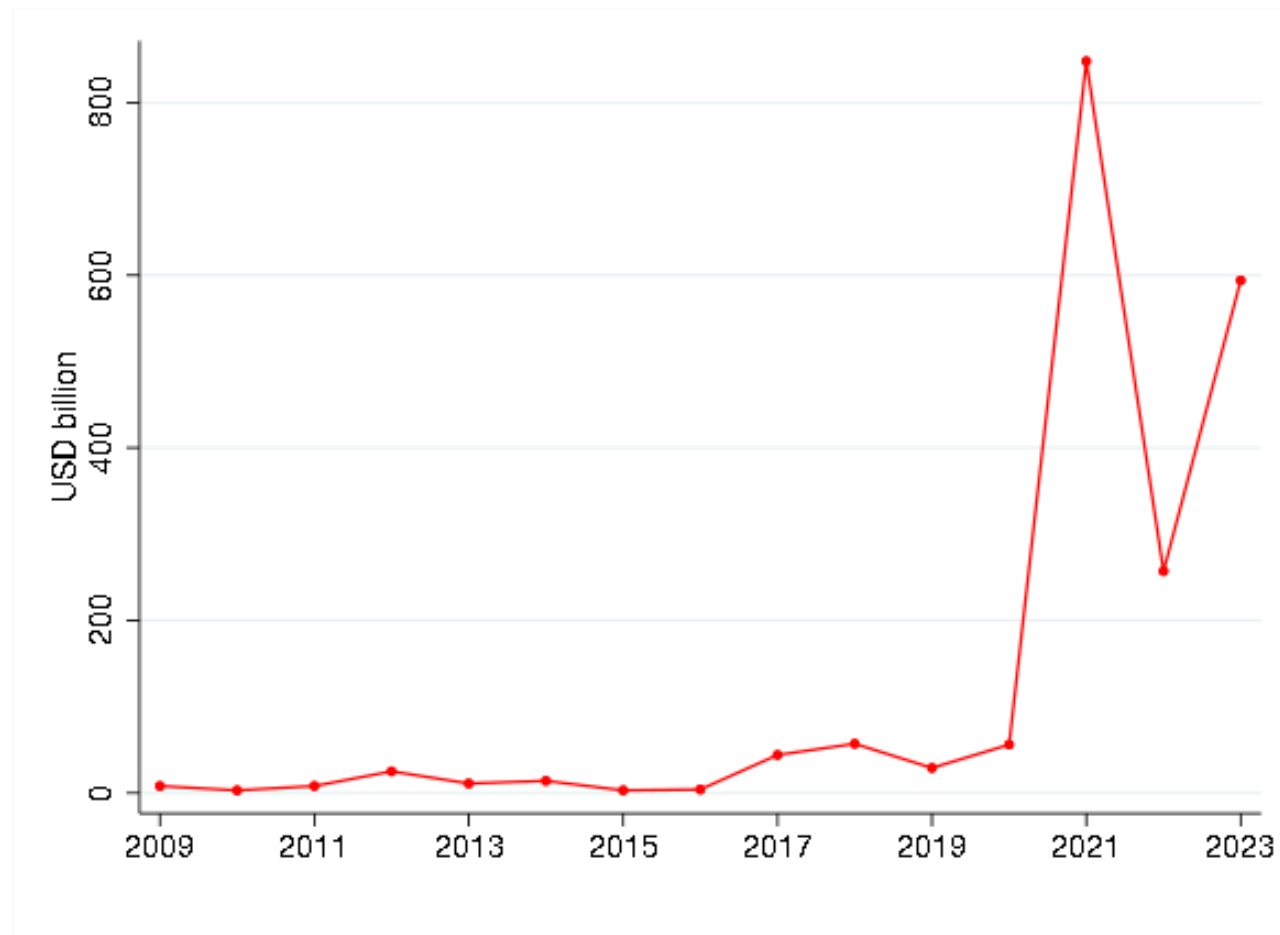
Convenience yields equalized at **29 bps**

Reserves+ONRRP=\$593B

Vertical black line: $Treasuries^{Private}$ given that Fed currently holds Treasuries and MBS

5. Estimating the convenience-maximizing reserve supply for the US

Conv. max. supply over time



- Conv. max. value x ($R^{C(b)}$) for year i solves:

$$\widehat{A}_R + \widehat{B}_R * \ln(x) + \widehat{C}_R * \ln(Deposits)$$

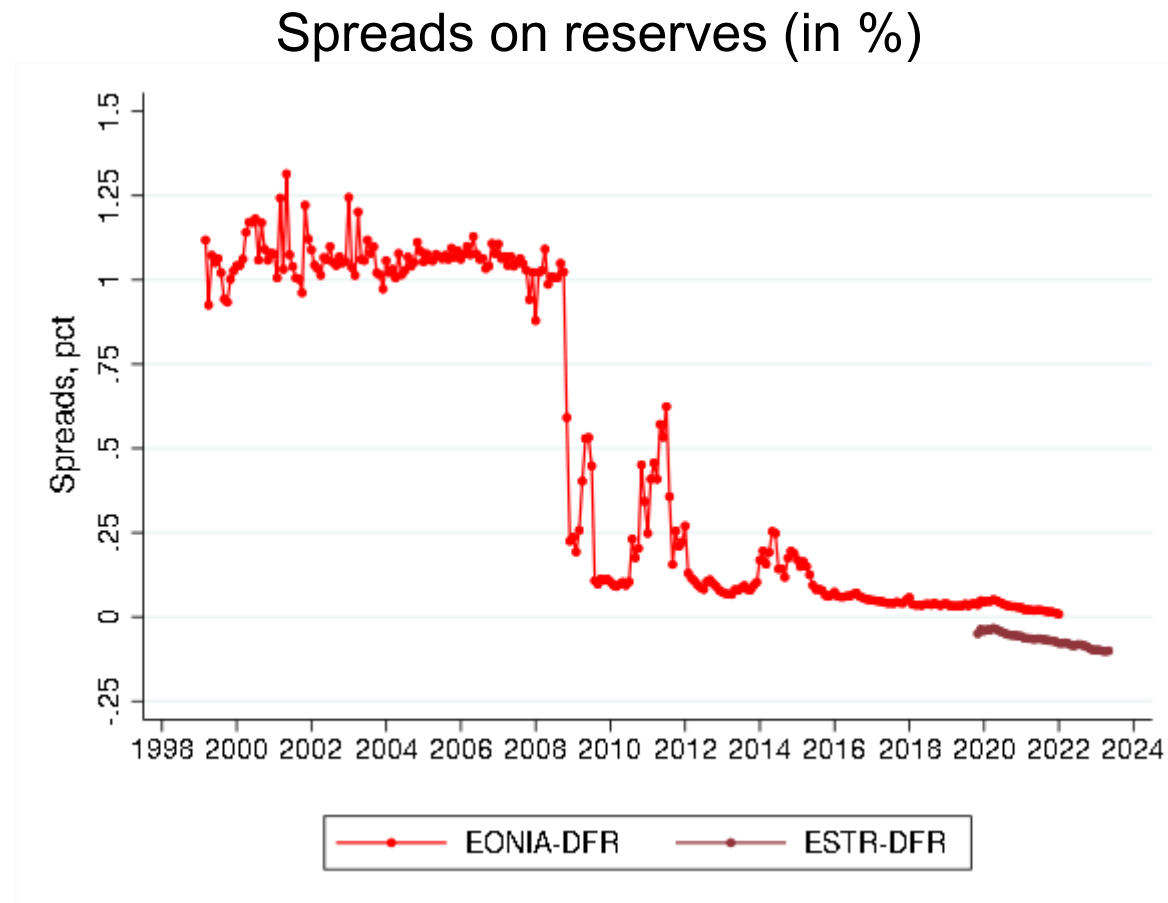
$$= \max \left(\widehat{A}_T + \widehat{B}_T * \ln \left(\frac{Treasuries - [x + AF]}{GDP} \right) + \widehat{\beta}_i - \widehat{C}_T, 0 \right)$$

- Fluctuations over time due to:
 - Deposits, GDP, Treasuries, autonomous factors
 - Shifts in Treasury convenience yield curve $\widehat{\beta}_i$
- $Deposits \uparrow \rightarrow$ Reserves scarcer $\rightarrow R^{C(b)} \uparrow$
 $Treasuries \uparrow \rightarrow$ Treasuries are less scarce $\rightarrow R^{C(b)} \uparrow$

5. Estimating the convenience-maximizing reserve supply for the euro area

Yield spreads on reserves (relative to inconvenient assets)

Monthly data, 1999M2-2023M4



- Measure $v'_R(\cdot) - \varphi$ by: ESTR (or EONIA-8.5 bps)-DFR
April 2023: **-10 bps**
- Spike around European sovereign debt crisis, likely related to bank default-risk → Estimate euro area reserve demand for **2013M1-2023M4**

5. Estimating the convenience-maximizing reserve supply for the euro area

Estimating reserve demand

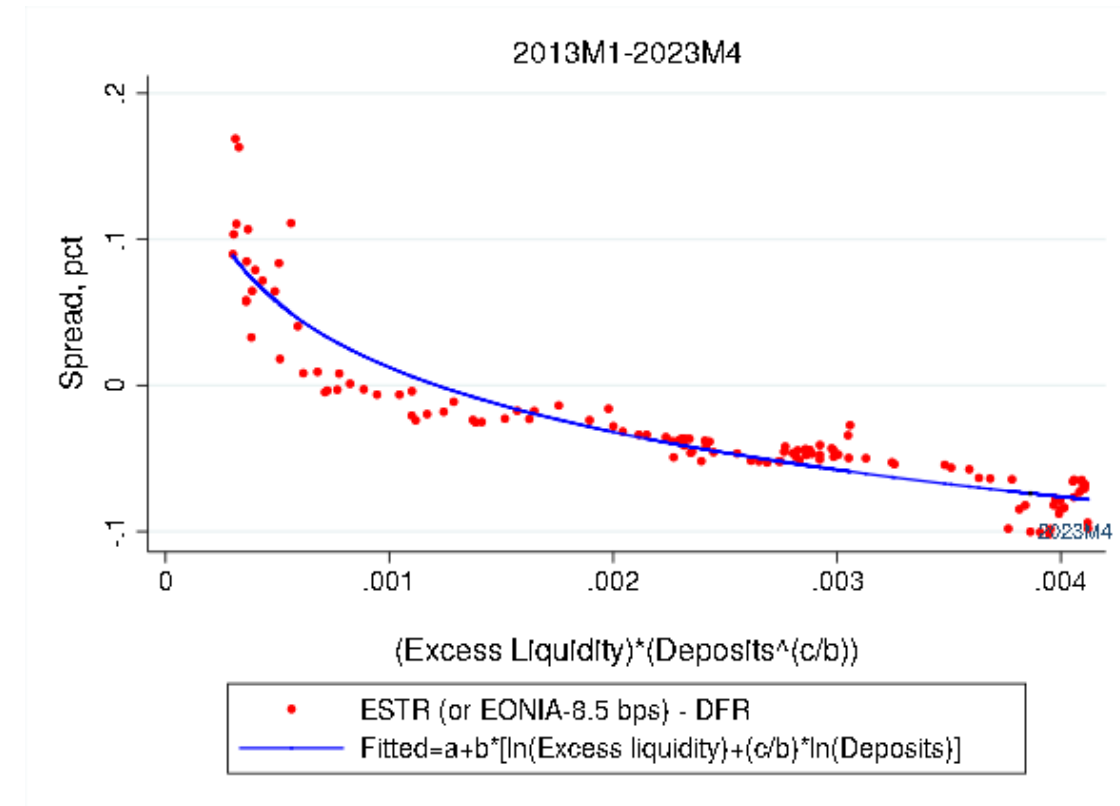
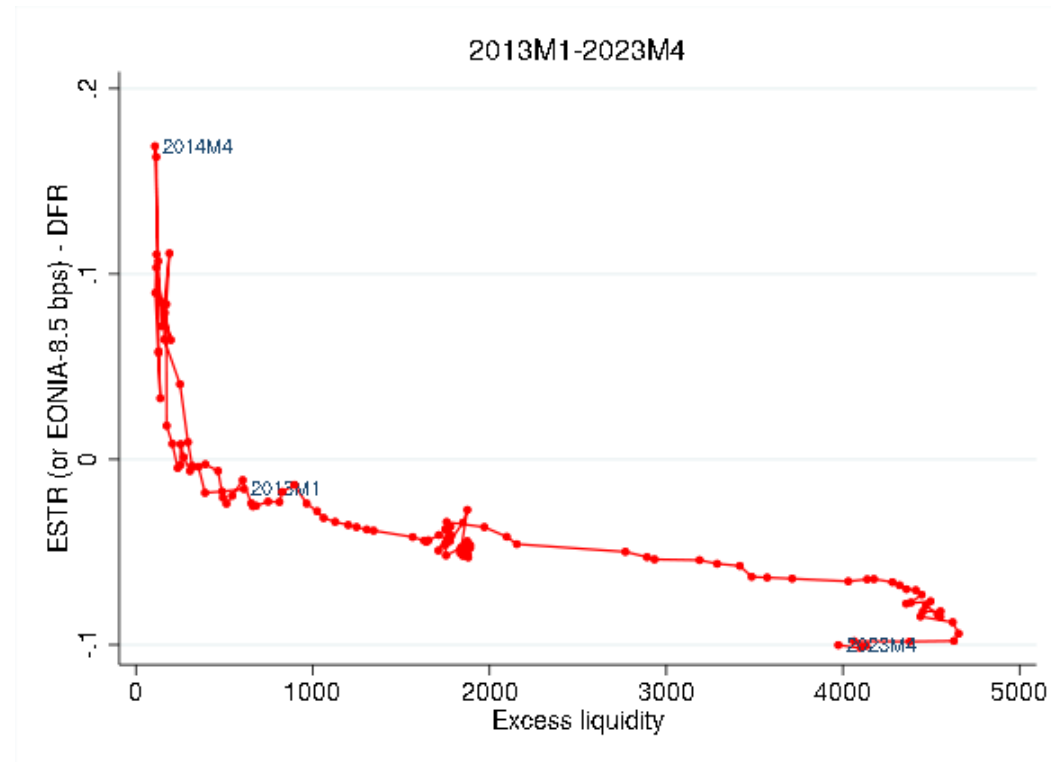
$$ESTR - DFR = a + b * \ln(\text{Excess Liquidity}) + c * \ln(\text{Deposits}) + u$$

$$= a + b * \ln \left[\underbrace{(\text{Excess Liquidity}) * (\text{Deposits})^{\frac{c}{b}}}_{\text{Deposit-adjusted excess liquidity supply}} \right] + u$$

- **Excess liquidity (excess reserves)** = [Current account holdings+deposit facility holdings]-[Required reserves]
- No ONRRP facility → **Don't need to instrument for reserves**
- Fit slightly better controlling for **overnight deposits** rather than total deposits
- Monthly data, 2013M1-2023M4

5. Estimating the convenience-maximizing reserve supply for the euro area

Estimating reserve demand

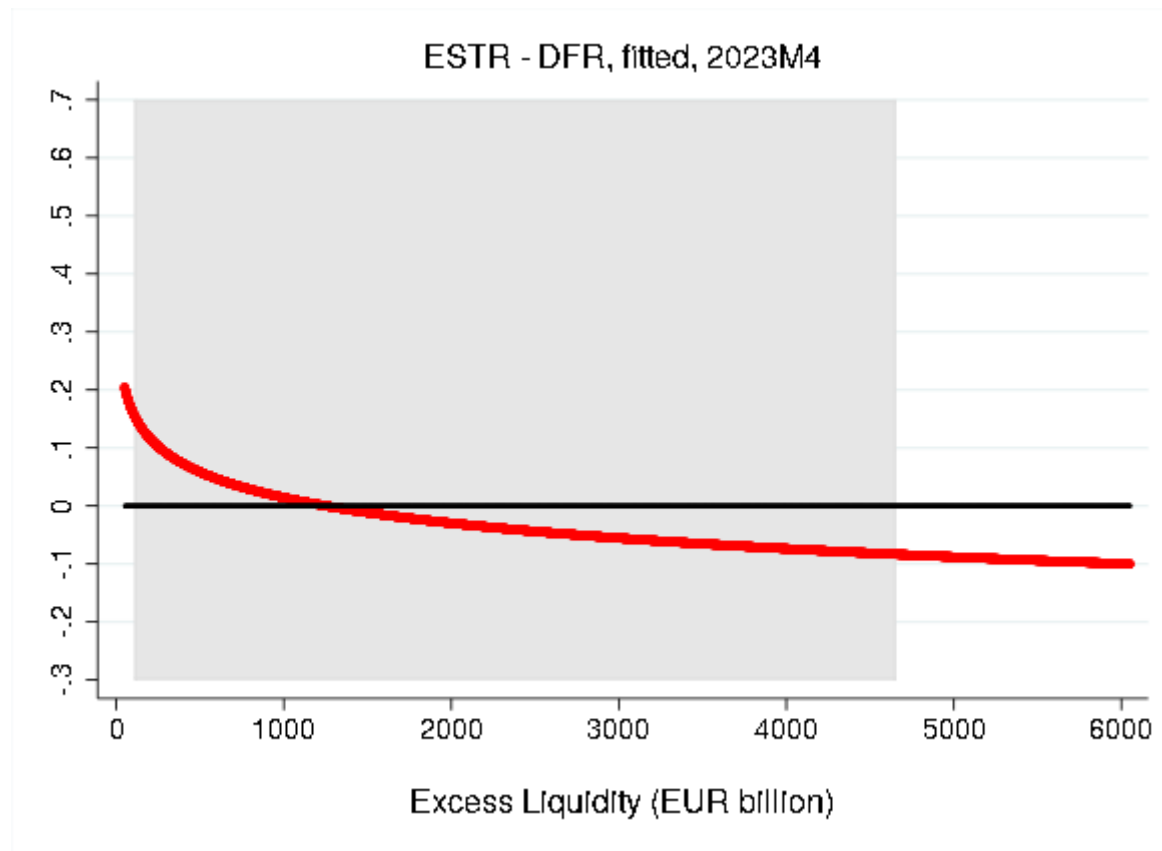


- Correlation($\ln(\text{Excess liquidity})$, $\ln(\text{Deposits})$)=0.94 (0.86 for the US)
- But ignoring deposits would incorrectly give constant convenience-maximizing supply for all years
- Could try other **functional forms** to get more curvature for low deposit-adjusted excess liquidity supply

5. Estimating the convenience-maximizing reserve supply for the euro area

Case (a): Convenience-maximizing reserve supply: Reserves supplied via inconvenient assets

April 2023:



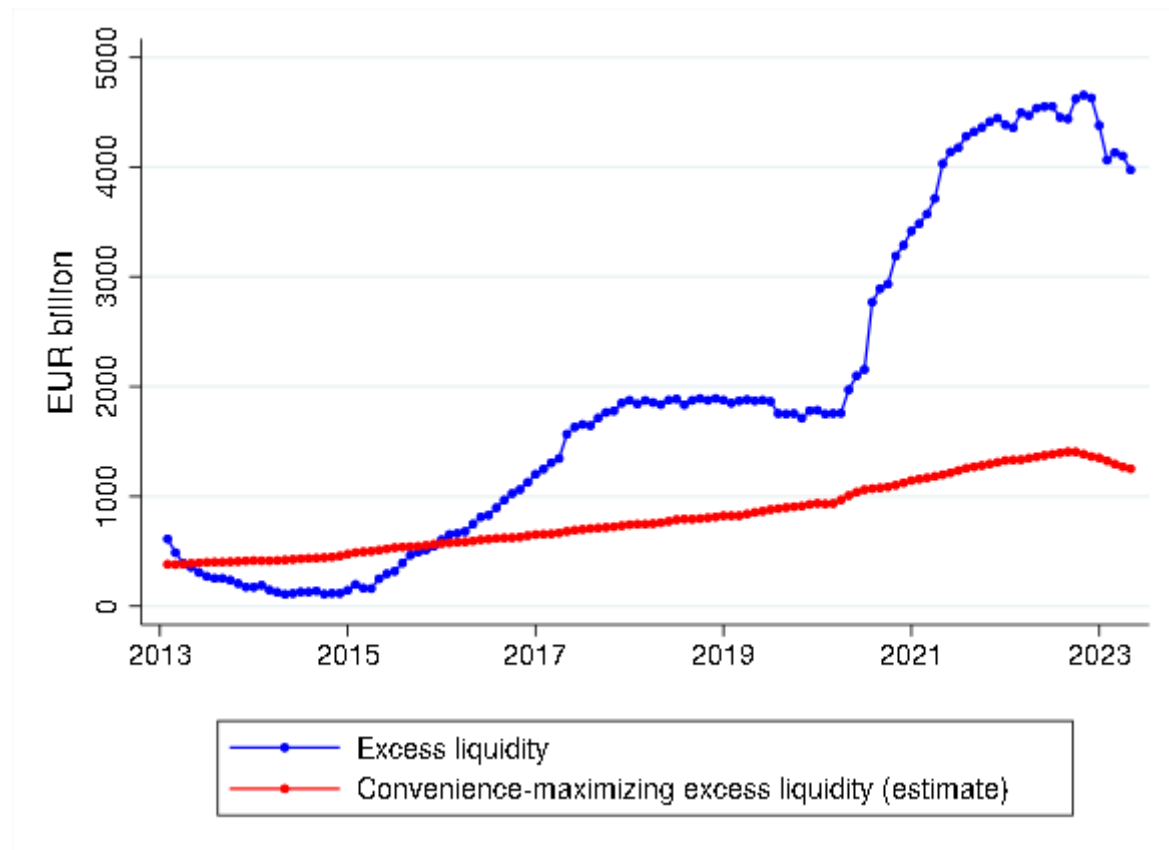
Gray shaded area: Range of data used in estimation

- $v'_R(\cdot) - \varphi = \hat{a} + \hat{b} * \ln(\text{Excess Liquidity}) + \hat{c} * \ln(\text{Deposits})$
using overnight deposits for April 2023: € 9.4T
- $v'_R(\cdot) - \varphi = 0$:

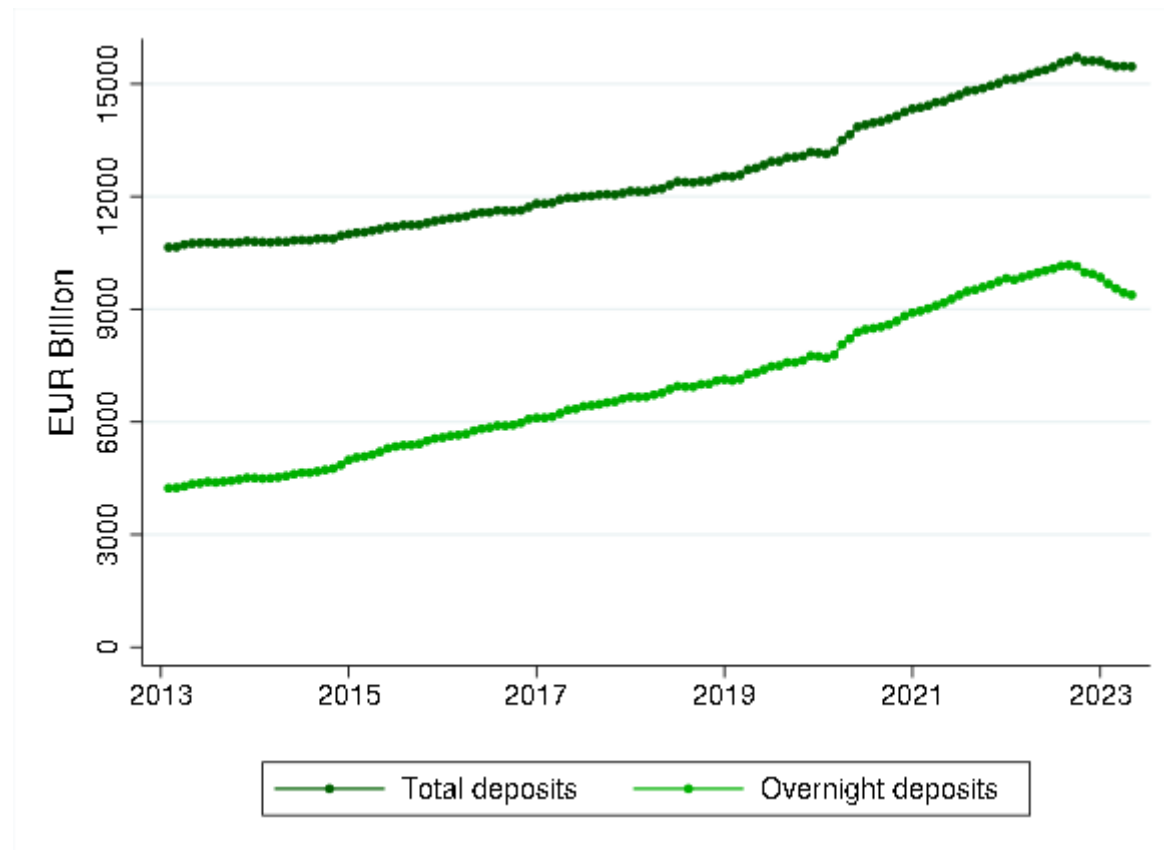
Excess liquidity	= € 1.251T
+ Required reserves	€ 165B
<u>Liquidity</u>	<u>= € 1.416T</u>
- Likely somewhat higher than the true convenience-maximizing value (functional form issue mentioned)

5. Estimating the convenience-maximizing reserve supply for the euro area

Conv. max. supply over time



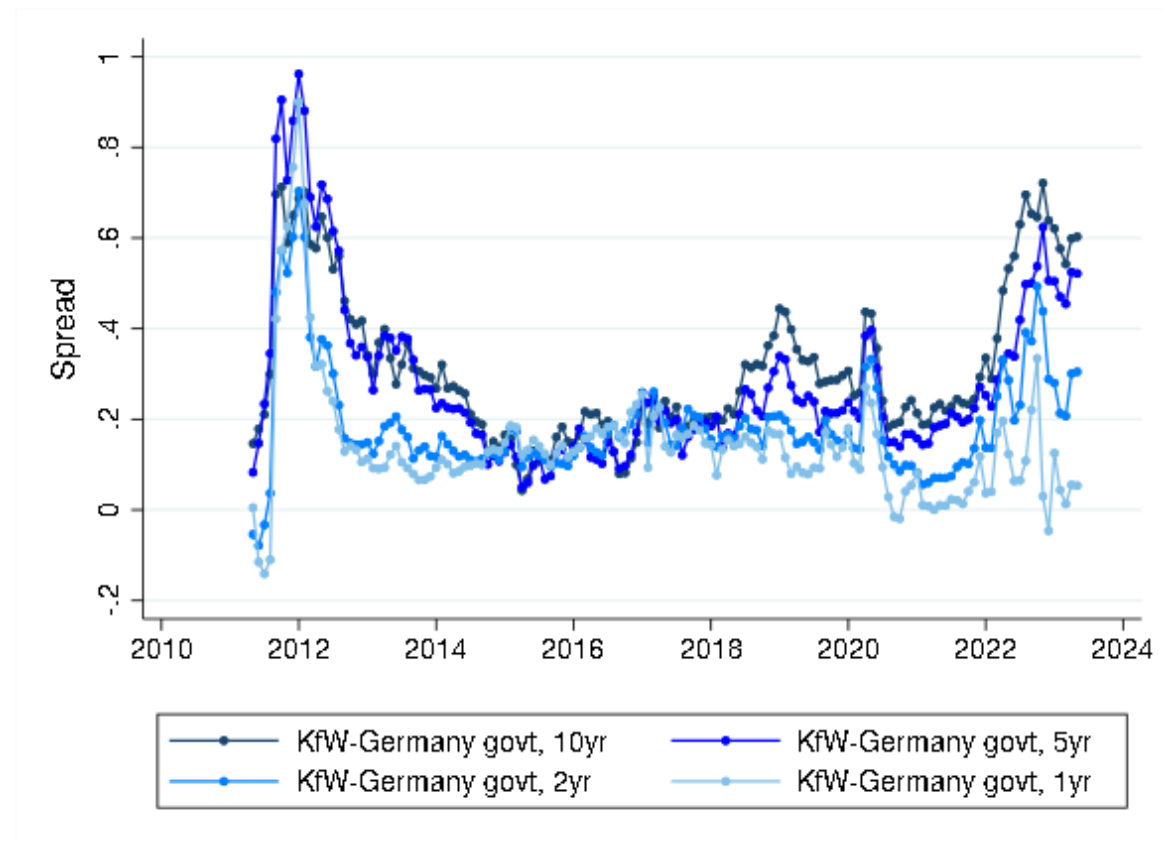
Deposits



5. Estimating the convenience-maximizing reserve supply for the euro area

*ECB can supply reserves via **inconvenient assets**. Does that matter? Yes, back of the envelope case (b) calculation*

Spreads on government bonds: Germany



Measure **Bund convenience yield** by **KfW - Bund** spread (likely an underestimate)

- April 2023: 10-year maturity: **60 bps**
2-year maturity: **30 bps**

5. Estimating the convenience-maximizing reserve supply for the euro area

- If ECB supplied reserves via government bonds only ($\omega = 1$), in proportion to capital key (Germany: $\alpha_1 = 0.214$)
- If only German Bunds (B_1) have convenience yields

$$v'_R(R) - \varphi = \underbrace{v'_B(B_1^{priv})}_{\substack{\text{Currently around 40 bps} \\ \text{(from KfW-Bund spreads)} \\ \text{but will fall as } B_1^{priv} \text{ increases}}} * \underbrace{\omega}_{=1} * \underbrace{\alpha_1}_{=0.214}$$

$$\rightarrow v'_R(R^{c(b)}) - \varphi \leq 8 \text{ bps}$$

$$\rightarrow \text{Liquidity} \geq \text{€521B}, < \text{€1.4T}$$

Conclusion

Laid out framework for thinking about **balance sheet policy when $r > \text{ELB}$** : Central role of **convenience yields**

- “**Convenience-maximizing**” reserve supply depends on **asset choice** which is affected by **political constraints**

(a) If reserves are supplied via central bank holdings of assets **without convenience yields**:

$$v'_R(.) - \varphi = 0$$

Reserves are **not scarce** at optimum

ECB?

(b) If reserves are supplied via central bank holdings of assets **with convenience yields**:

$$v'_R(.) - \varphi = v'_B(.)$$

Reserves are **scarce** at optimum

Federal Reserve?