Convenience Yields and Monetary Policy

Annette Vissing-Jorgensen, Federal Reserve Board

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What is a convenience yield?

Investors care about expected returns and risk. For fixed income investments:

- Return comes from interest and principal payments
- However, there may be an additional aspect to investors' return

Convenience yield:

- A return over and above interest and principal payments
- A cost saving from choosing this asset

Where does convenience yield come from?

- From liquidity: Saved transactions costs/payment delay costs
- From safety: Saved information costs due to low default risk (no need for credit risk analysis)
- Both interact with supervision and regulation:
  - Ex. Banks face reserve requirements and liquidity requirements

Convenience yields: At the heart of monetary economics and monetary policy

One could define money as an asset with a convenience yield

- People, firms, banks, and governments are willing to accept lower interest or principal payments on money-like assets: True return on money includes convenience yield

Role of convenience yields in central banking is more subtle than you may think

- Many different convenience yields are involved
- Changing focus on different convenience yields over time

Today's lecture: Describe key results from various papers of mine

- Traditional central banking
- Quantitative easing and quantitative tightening.

Outline

1. Basics: The central bank's balance sheet and objectives

2. Convenience yield on reserves: Shapes reserve demand. Important for:
   - Interest rate control
   - Quantitative tightening

3. Convenience yield on Treasuries: Shapes Treasury demand. Important for:
   - Quantitative easing

4. Equalizing convenience yields on reserves and Treasuries
   - A convenience-maximization perspective on quantitative tightening

THE BASICS: THE CENTRAL BANK'S BALANCE SHEET AND OBJECTIVES

Basics: The central bank's balance sheet and objectives

Main components of a typical central bank balance sheet:

Assets	*Liabilities*
Securities	Currency
Loans to banks	Government deposits
	Reserves

The central bank liabilities listed are types of money. All are very liquid and safe

1. Currency (cash): Used as medium of exchange (cheaper than barter)
2. Government deposits: Used to manage payments from taxes, spending and debt
3. Reserves: Used by banks for settlement purposes to move funds between banks
   - Also held due to reserve requirements (and liquidity requirements) imposed on banks
   - If reserves earn interest, they can also become attractive as an investment (store of value)

Basics: The central bank's balance sheet and objectives

Demand for central bank money:

$v(Money,.)$: Convenience *value* of money -- expected total cost savings from money holdings

- Will in general also depend on other arguments, as I will discuss below

$v'_M(Money,.)$: Convenience *yield* on money -- the marginal value of $1 of money

- Conv. yield is typically declining with additional money holdings: Additional units of money are less and less likely to be useful

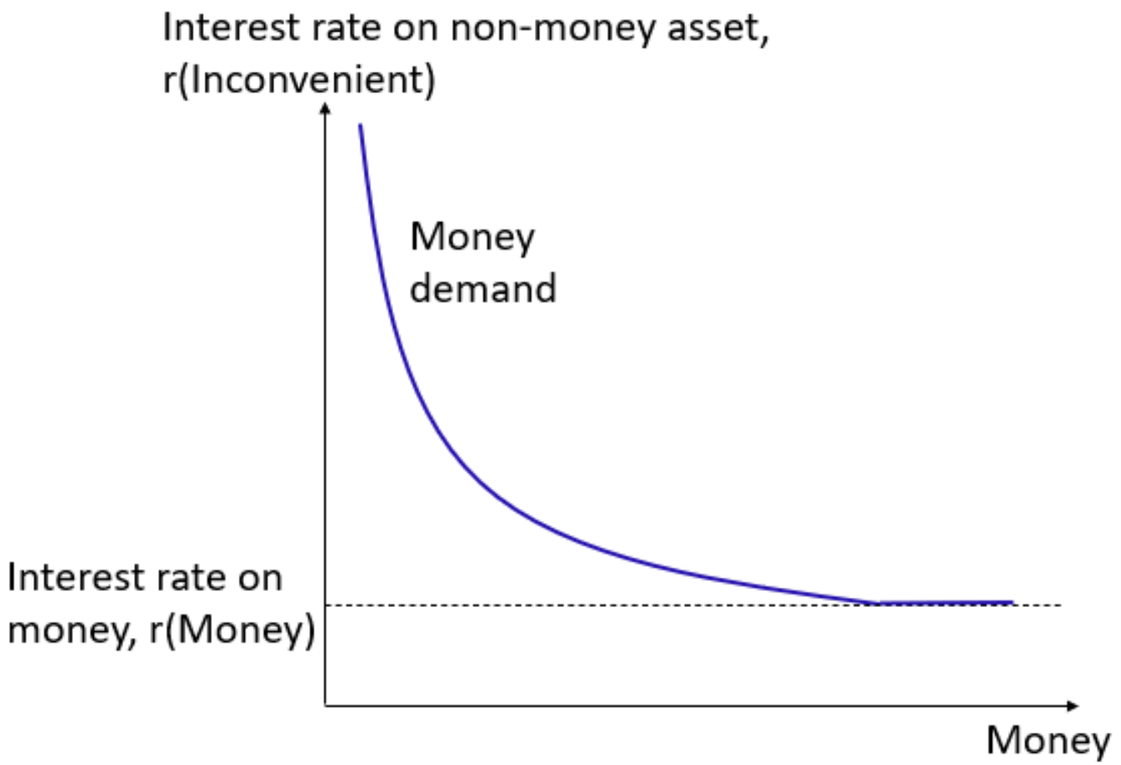
First-order condition for money demand relative to less liquid/safe asset:

- Hold money to the point that overall returns are equalized

$$r(Inconvenient) = r(Money) + v'_M(Money,.) \quad (1)$$

- Traces out money demand as a function of interest rate on non-money

Basics: The central bank's balance sheet and objectives



$$r(Inconvenient) = r(Money) + v'_M(Money, .)$$

- Slope: $v'_M(Money, .)$ declining with holdings
- Level: Determined by $r(Money)$ (=0 for currency)
- Asymptote: $r(Money)$, reached if there's a saturation point for convenience

Basics: The central bank's balance sheet and objectives

Supply of central bank money: What are the central bank's objectives in setting supply?

1. Facilitating payments: Supplying money improves welfare via its convenience yield
2. Monetary policy: Ensure low inflation and (for some central banks) maximum employment
3. Financial stability: Lender of Last Resort function and supervision and regulation role

Typical approach:

- Supply reserves to target monetary policy interest rate
- Supply currency and government deposits elastically:
  - Accommodate demand (facilitate payments) elastically at prevailing interest rates
  - Currency and government deposits are therefore referred to as *autonomous factors*

THE CONVENIENCE YIELD ON RESERVES: IMPLICATIONS FOR INTEREST RATE CONTROL AND QUANTITATIVE TIGHTENING

Lopez-Salido and Vissing-Jorgensen (2023, working paper)

Reserve demand

Bank Assets	*Bank Liabilities*
Reserves	Deposits
Securities, loans	Interbank and central bank borrowing
Interbank lending	Equity

1. Interest on reserves: IOR
2. Reserves are needed to satisfy reserve requirements (if any)
3. Reserves have convenience benefits: Don't have to sell illiquid assets/cut lending/delay payments if deposits drop

   Also useful for supervision & regulation purposes

$v(ExcessReserves, Deposits)$	Convenience value: Expected savings on transactions costs/other costs
$v'_R(ExcessReserves, Deposits)$	Convenience yield: Marginal value of more reserves Decreasing in reserves, increasing in deposits

4. Bank balance sheet cost φ per dollar of assets (capital requirements)

Reserve demand

FOC for reserves versus interbank lending: Holds for banks active in interbank lending

$$r = IOR + v_R'(ExcessReserves, Deposits) \qquad (2)$$

r: Short market rate in interbank market

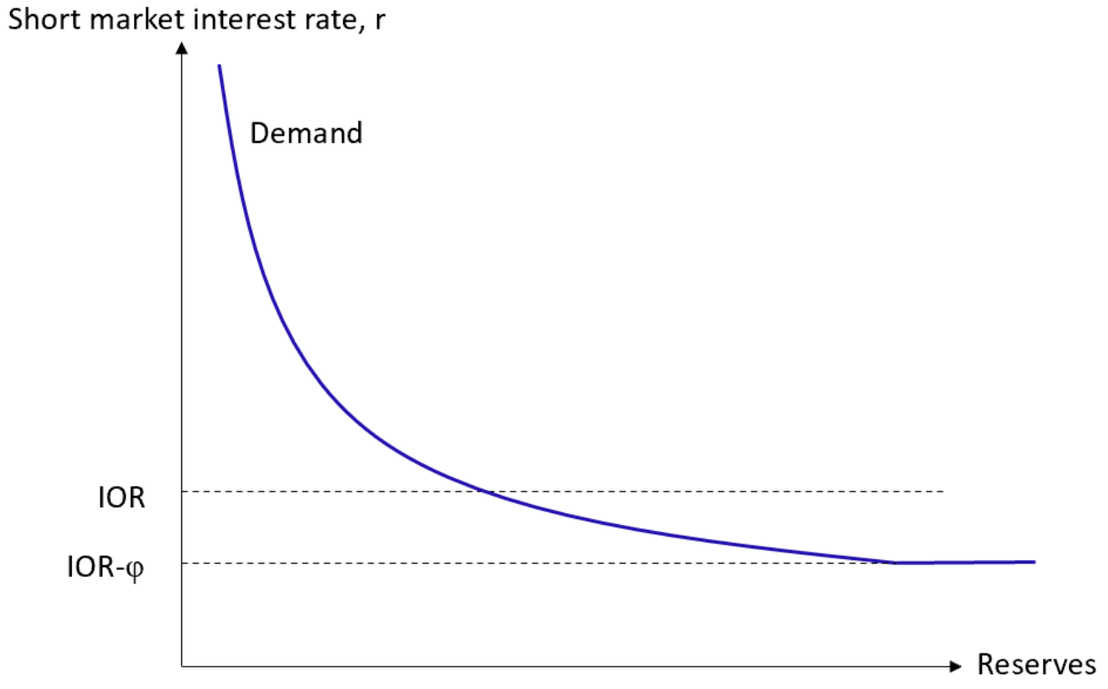
FOC for borrowing to hold more reserves: Holds for banks active in interbank borrowing

$$\underbrace{r}_{\substack{\text{Highest interest rate bank} \\ \text{is willing to pay to borrow} \\ \text{to invest in additional reserves}}} = \underbrace{IOR + v_R'(ExcessReserves, Deposits) - \varphi}_{\text{Net benefit of additional reserves}} \qquad (3)$$

(3) more relevant post-GFC in the US: Banks borrow from non-banks

Reserve demand

$$r = \text{IOR} + v_R'(ExcessReserves, Deposits) - \varphi$$



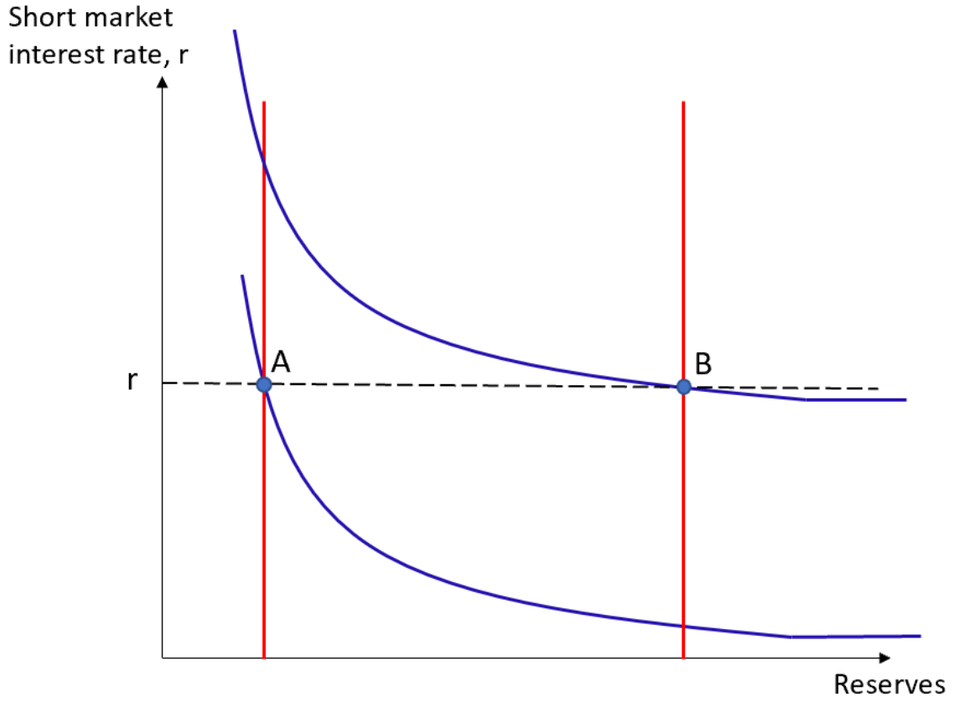
- Demand for reserves:
  - Slope: Comes from $v_R'(.)$
  - Level: Shifts up with IOR, down with φ
  - Location: Shifts right with req. reserves
  - Asymptotes to IOR-φ if $v_R'(.) \rightarrow 0$
- Reserve scarcity is measured by $v_R'(.)$:
  - Scarce: $v_R'(.) \gg 0$
  - Ample: $v_R'(.) > 0$ but only slightly so
  - Abundant: $v_R'(.) = 0$

Interest rate control: Too many tools

A central bank has more tools than it needs to control the short market interest rate:

- Controls reserve *demand* via *IOR* and reserve requirements
- Controls reserve *supply*

Chosen configuration of these tools: Operating framework – size of reserve convenience yield



A: Scarce reserves framework

$$v_R'(.) \gg 0$$

Low IOR. Low supply relative to demand

B: Ample reserves framework

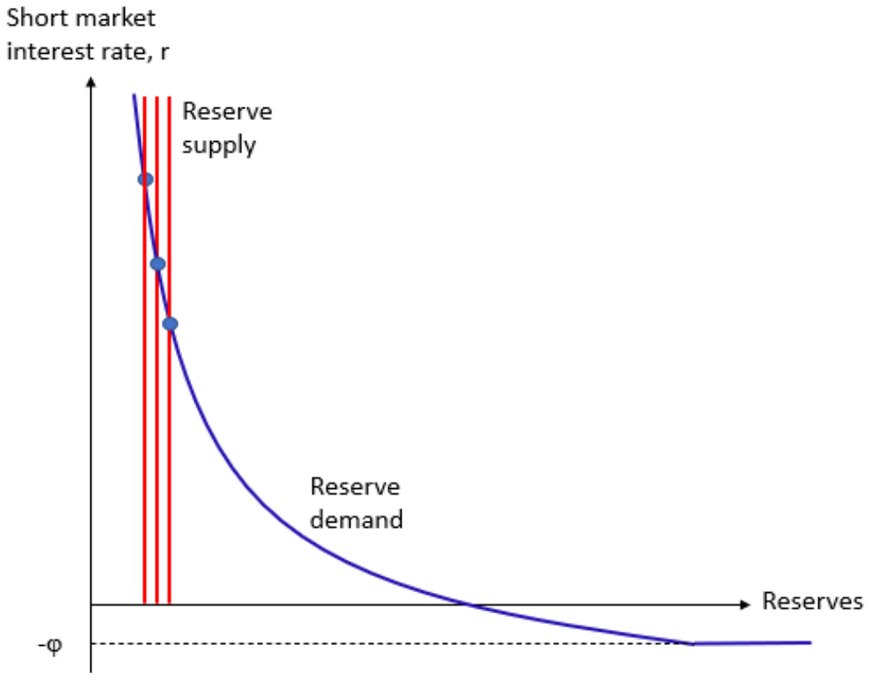
$v_R'(.) > 0$ but only slightly

High IOR. High supply relative to demand

Interest rate control: What needs to be done to hit the target?

	Pre-GFC	*Post-GFC*
Federal Reserve	IOR=0, very scarce reserves	IOR≠0, ample reserves
ECB	IOR≠0, somewhat scarce reserves	IOR≠0, ample reserves

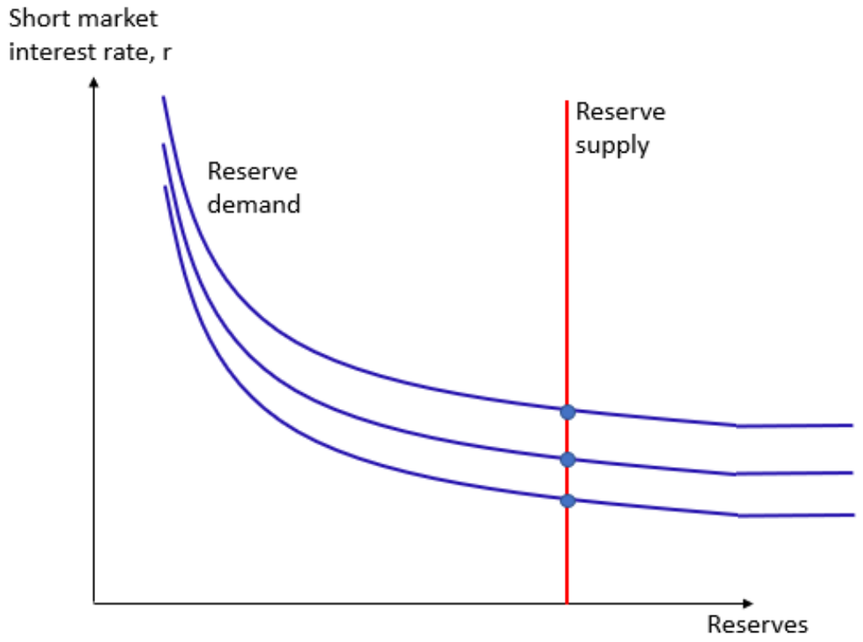
Scarce reserves regime with IOR=0



1. Change *reserve supply* when the target rate is changed (small shifts are sufficient)
2. Accommodate reserve demand shifts (due to deposit changes or reserve demand shocks) with equal changes in asset size and thus reserve supply
3. Accommodate changes in autonomous factors with equal changes in asset size: Keep reserve supply unaffected

Interest rate control: What needs to be done to hit the target?

Ample reserves regime



Reserve supply is driven by QE/QT (or other objectives), not interest rate control

1. Set IOR to affect *reserve demand* in order to hit target given reserve supply. Change IOR when target changes or reserve supply changes
2. Accommodate substantial changes in reserve demand with equal changes in asset size and thus reserve supply
3. Accommodate substantial changes in autonomous factors with equal changes in asset size: Keep reserve supply unaffected

Less urgent to accommodate small changes in reserve demand or autonomous factors

Important to know shape of reserve demand to set IOR and assess when substantial scarcity emerges

Estimating the reserve demand function in ample reserves regime

- Assume $v_R'(.) - \varphi$ is log-linear. Allow for a reserve demand shock u

$$v_R'(ExcessReserves, Deposits) - \varphi = a + b * \ln(ExcessReserves) + c * \ln(Deposits) + u$$

- Reserve demand:

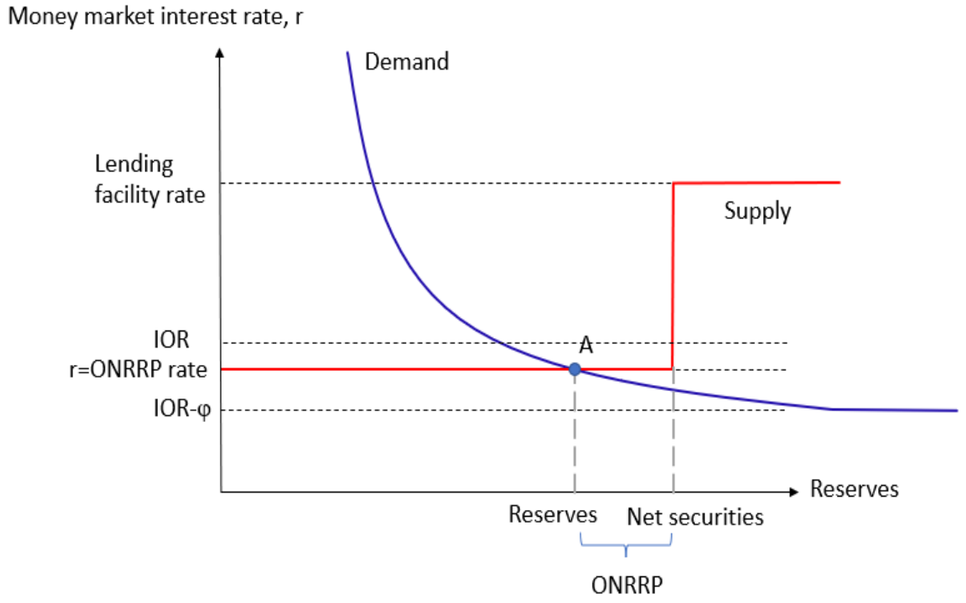
$$r - IOR = a + b * ln(Excess\ Reserves) + c * ln(Deposits) + u$$

- US data, monthly, 2009M1-2023M10
  - r: Effective Federal funds rate (interbank market)
  - Both excess reserves and deposits are nominal so account for prices changes
  - Similar results with liquid deposits rather than total deposits
  - Important to instrument for Excess Reserves
  - Controlling for deposits is important, but instrumenting for deposits is not

Estimating the reserve demand function in ample reserves regime

Fed Assets	*Fed Liabilities*
Securities	Autonomous factors
Loans to banks	Reserves
	ONRRP

$$\text{Reserves} = \underbrace{[\text{Securities} - \text{Autonomous factors}]}_{Net\ securities} + \text{Loans to bank} - \text{ONRRP}$$

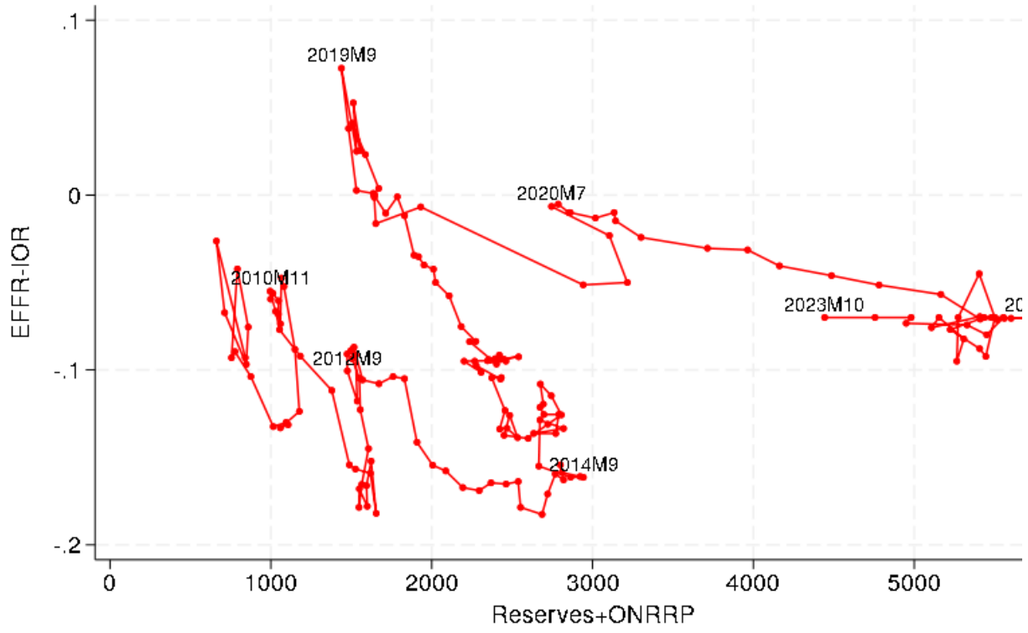


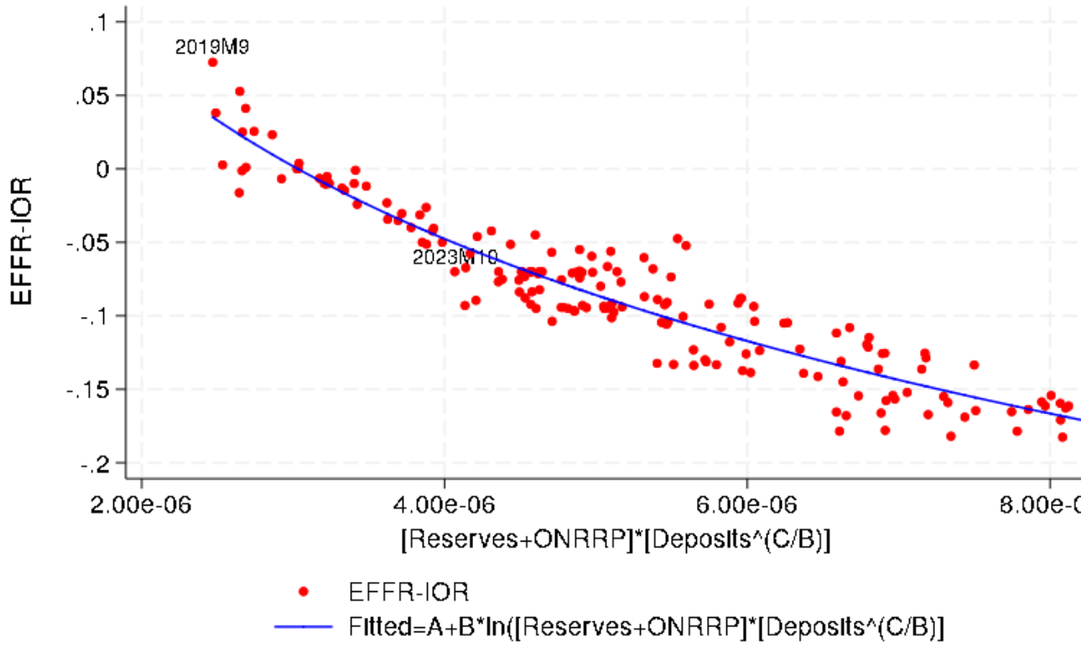
- Along a horizontal part of the supply curve: Reserve demand shocks affect reserves
- Instrument Excess Reserves w/Reserves+ONRRP (=Net sec's when loans to banks are small)

Estimating the reserve demand function in ample reserves regime

Reduced form of IV: $$EFFR - IOR = A + \mathrm{B} * ln(Reserves + ONRRP) + C * ln(Deposits) + U$$

$$= A + \mathrm{B} * ln\underbrace{\left[(Reserves + ONRRP) * (Deposits)^{\frac{C}{\mathrm{B}}}\right]}_{Deposit-adjusted\ Reserves+ONRRP\ supply} + U$$

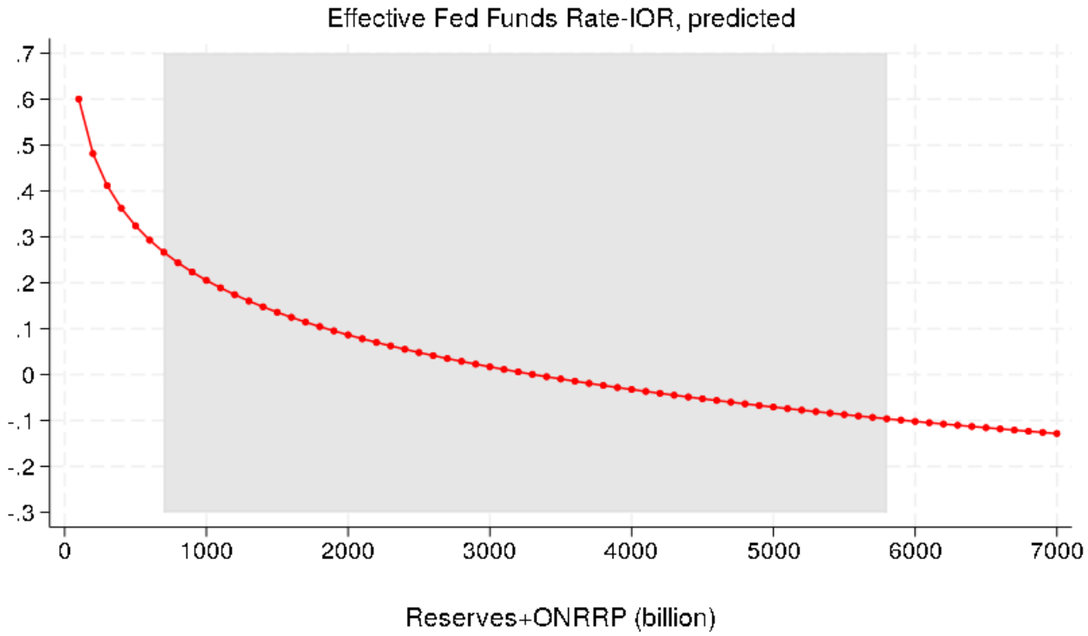




How to set the IOR to hit the target, given balance sheet size

Given deposits of $17.363T as of 2023M10:

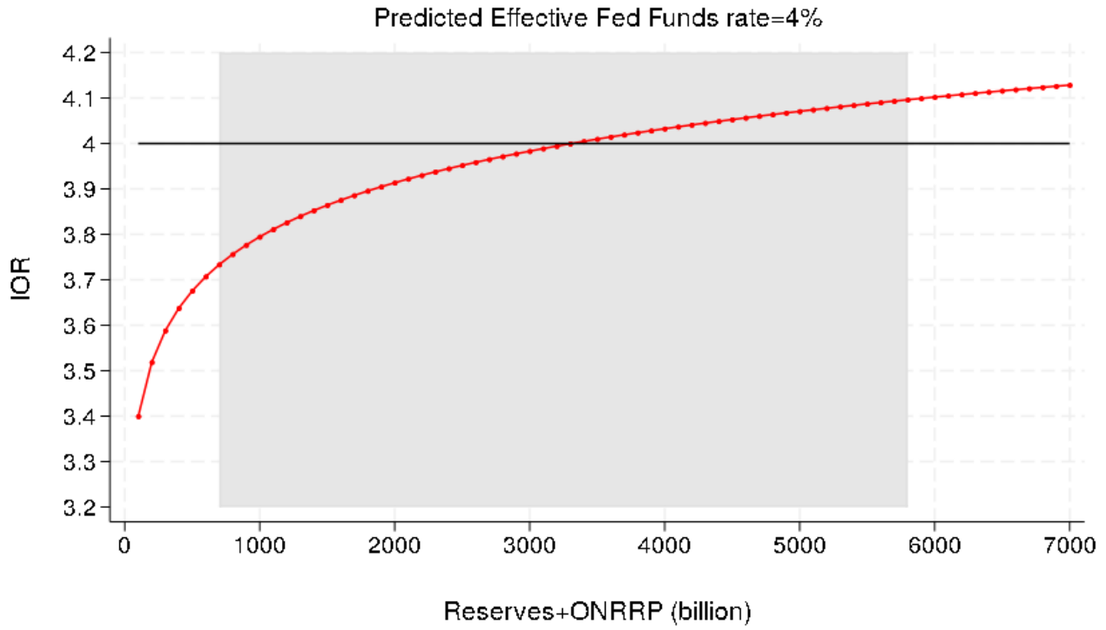
$$EFFR - IOR = \hat{A} + \hat{B} * ln(Res + ONRRP) + \hat{C} * ln(Deposits)$$



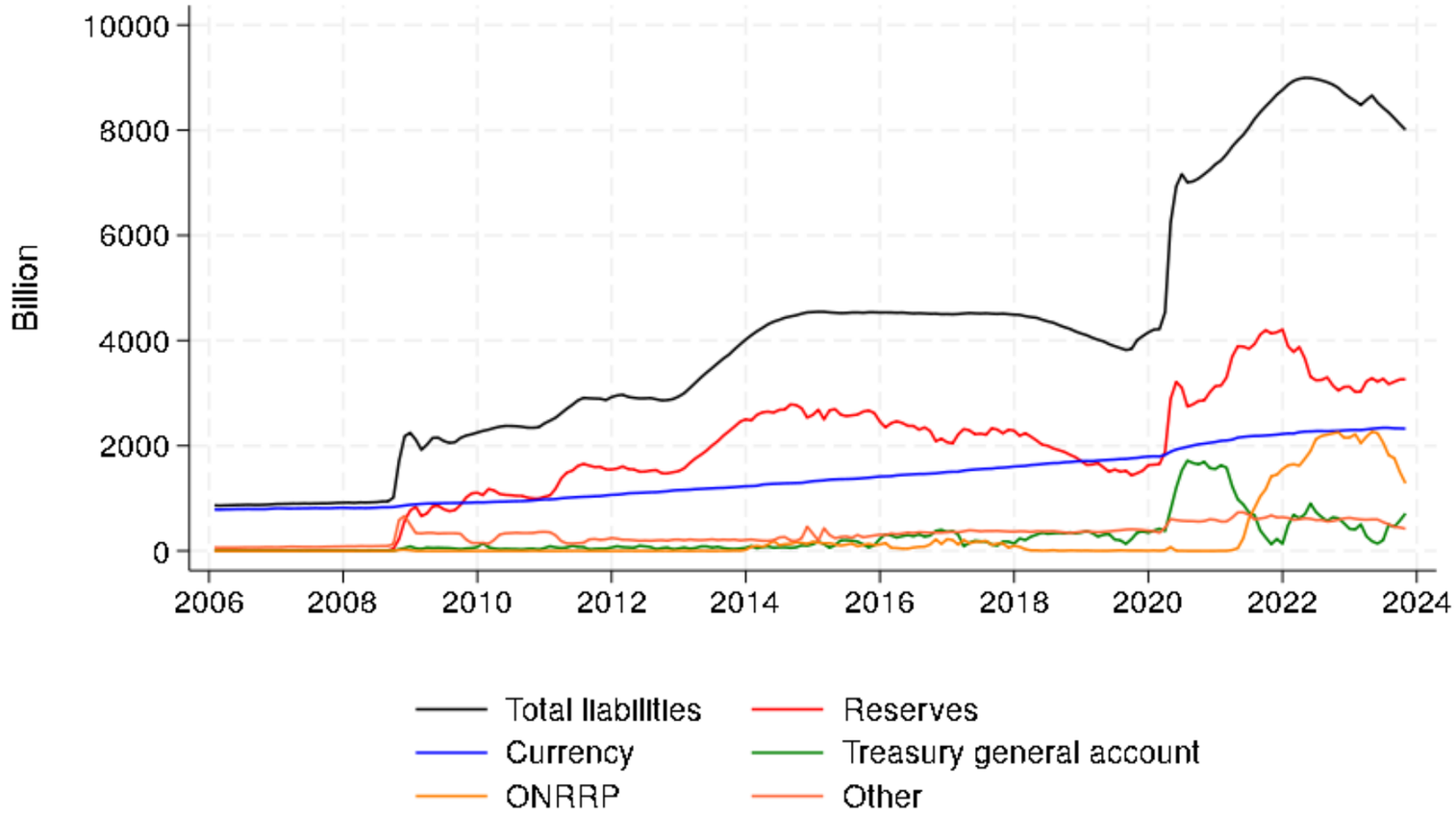
Gray shading: Observed x-range in sample (from $662B to $5,811B)

Iso-fed funds curve (ex. for a 4% target):

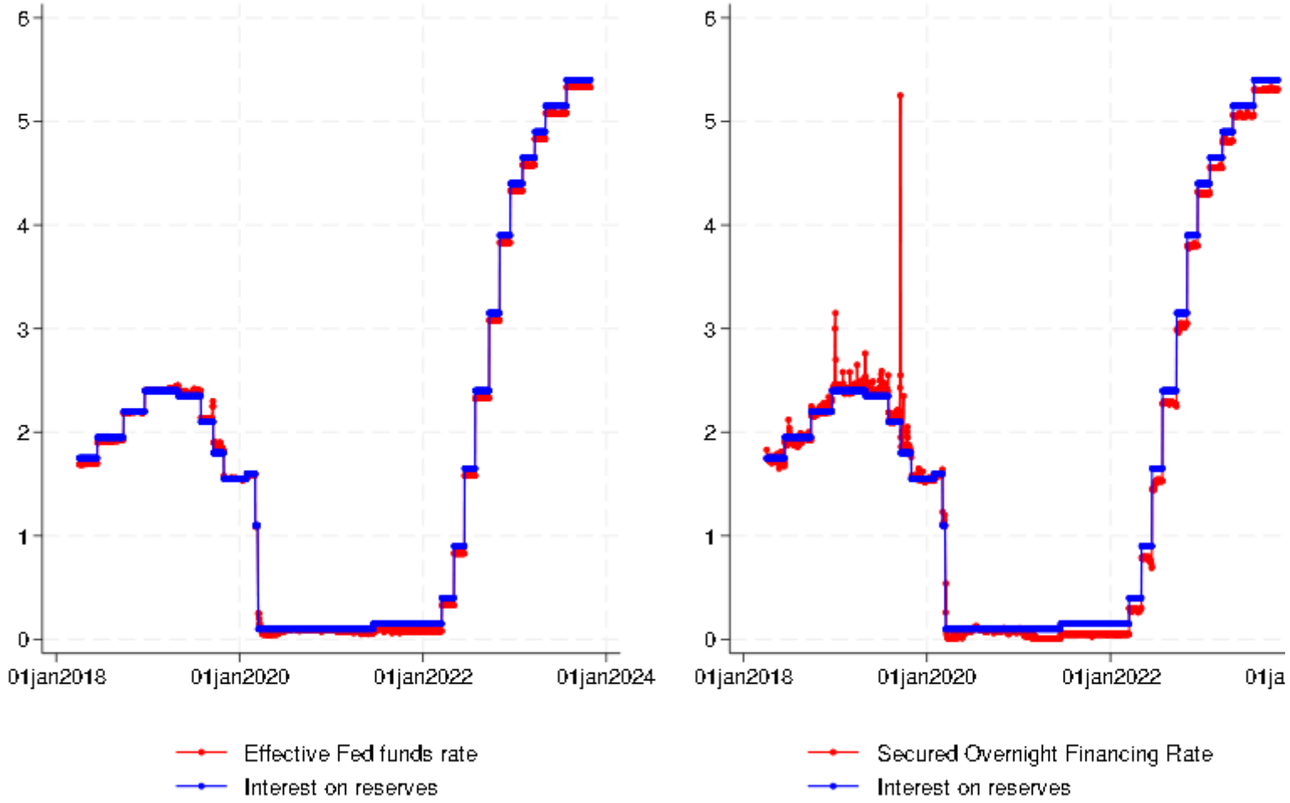
$$IOR = 4\% - [\hat{A} + \hat{B} * ln(Res + ONRRP) + \hat{C} * ln(Deposits)]$$



Federal Reserve liabilities, 2006M1-2023M10



Low reserve supply → Yield spikes, September 2019 (daily data)



- Sept 17, 2019: Reserve scarcity
- Market worries that current QT will end abruptly with another yield spike e.g., WSJ 9/3/2022

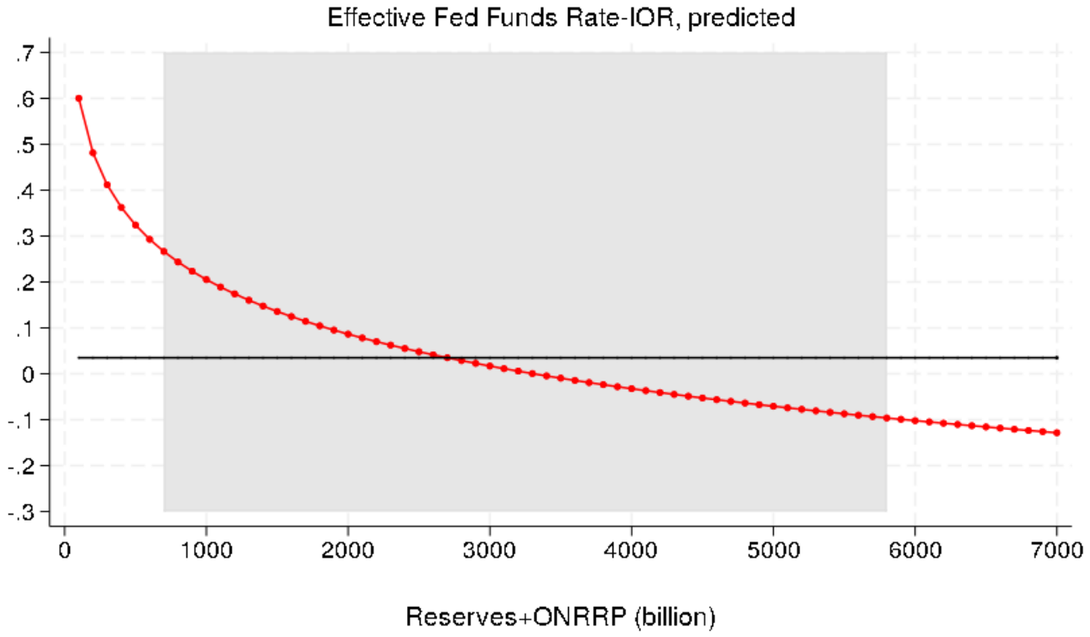
The Other Doomsday Scenario Looming Over Markets

A U.K. fund manager says the big worry isn't inflation, it's the reversing quantitative easing

Guiding QT: When is Reserves+ONRRP supply as tight as in September 2019?

Given deposits of $17.363T as of 2023M10:

$$EFFR - IOR = \hat{A} + \hat{B} * ln(Res + ONRRP) + \hat{C} * ln(Deposits)$$



Horizontal line marks 4 bps, the predicted value in Sept 2019.
Gray shading: Observed x-range in sample (from $662B to $5,811B)

- Sep 2019: Predicted EFFR-IOR=4 bps
- Oct 2023: Predicted EFFR-IOR=4 bps for Reserves+ONRRP=$2.7T (actual=$4.5T)
- Values around/below this value could be risky from an interest rate volatility perspective

THE CONVENIENCE YIELD ON TREASURIES: IMPLICATIONS FOR QUANTITATIVE EASING

Krishnamurthy and Vissing-Jorgensen (2012, 2011, 2013)

Vissing-Jorgensen (2023)

Quantitative easing: Why is it used? What is it?

- Effective lower bound (ELB): There's a limit to how low IOR and thus *r* can go

  Suppose banks can do the same with reserves and cash: Will hold cash if $IOR < r^{cash}$.

  $r^{cash} = 0$, or a bit negative given theft/storage costs, so IOR can only go a bit negative

- QE: Used because of the ELB
  - Large scale bond purchases to lower medium/long interest rates
  - For QE effectiveness, convenience yields on central bank *assets* also matter

How does QE affect r^{long}? "Quantitative and credit easing" would be better label

$$y^{Long} = \underbrace{Exp.\ avg.short\ rate}_{\substack{Signaling\ channel:\\ Quantitative\ easing}} + \underbrace{Term\ premium}_{\substack{Portfolio\ rebalance\ channels:\\ Credit\ easing}}$$

- Signaling channel:
  - Works via CB liabilities, like conventional monetary policy

    $Exp.\ avg.short\ rate = Exp.avg.(IOR + v_R'(ExcessReserves, Deposits) - \varphi)$

    Higher path for reserves → Lower reserve conv. yield path → Lower short rate path
  - There could be additional effects if QE signals that the IOR will be kept lower too

How does QE affect r^{long}? "Quantitative and credit easing" would be better label

$$y^{Long} = \underbrace{Exp.\ avg.short\ rate}_{\substack{Signaling\ channel:\\ Quantitative\ easing}} + \underbrace{Term\ premium}_{\substack{Portfolio\ rebalance\ channels:\\ Credit\ easing}}$$

- Portfolio rebalance channels: Works via CB assets

$$y^{Treasury} = Exp.\ avg.short\ rate + Duration\ risk\ comp. - \underbrace{v_T'(T)}_{Treasury\ convenience\ yield}$$

$$y^{Corporate\ bond} = Exp.\ avg.short\ rate + Duration\ risk\ comp. + Default\ risk\ comp.$$

$$y^{MBS} = Exp.\ avg.short\ rate + Duration\ risk\ comp. + Prepayment\ risk\ comp.$$

- Euro area: Sovereign default, currency redenomination, market segmentation terms (Nagel, Krishnamurthy & V-J (2018))

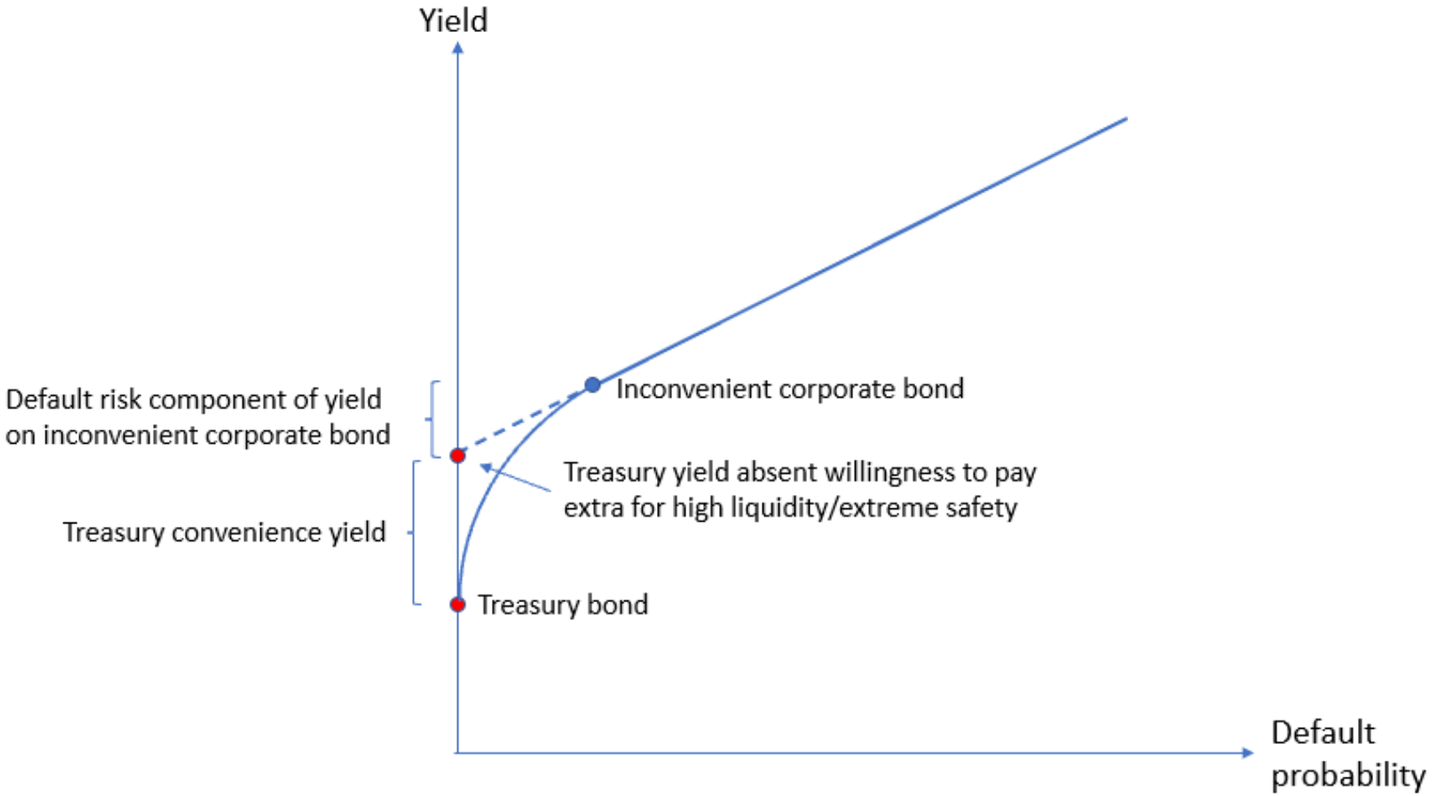
Treasury convenience yield: Why it matters for QE

My career took a turn toward central banking because of the Treasury convenience yield

- QE1 (started in Fall 2008): MBS (incl agency debt), Treasuries
- QE2 (started in Fall 2010): Treasuries
  - My coauthor Arvind Krishnamurthy and I worried that buying Treasuries would not be the most effective policy for stimulating the private sector
  - Would increase convenience yield on Treasuries, lowering Treasury yields more than yields on private sector securities
- QE3 (started Fall 2012): MBS, Treasuries

What is the Treasury convenience yield? Krishnamurthy and V-J (2012)

Convenience yield on Treasuries – theoretical diagram



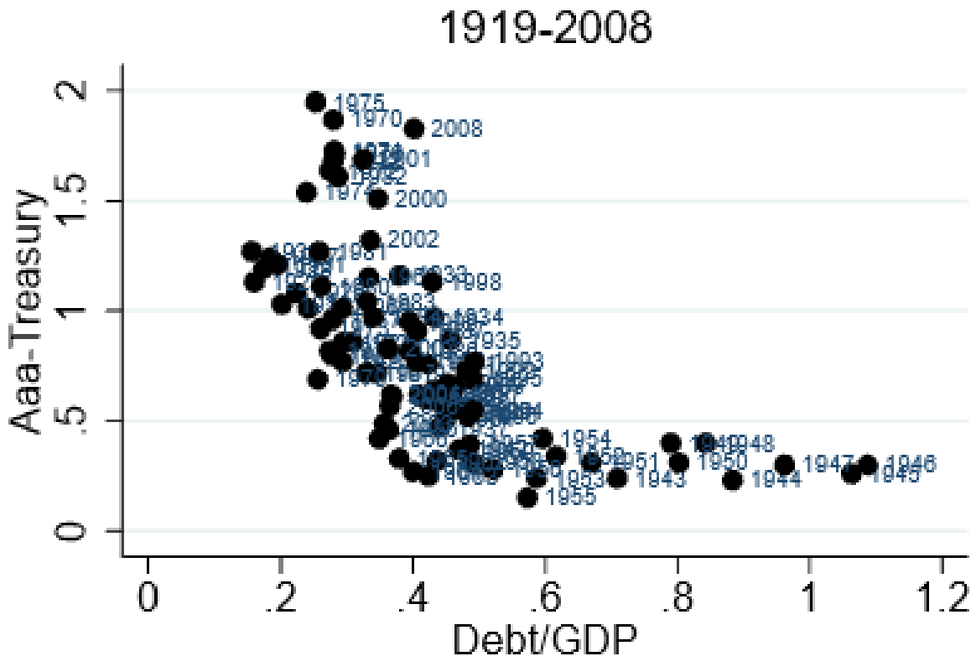
- Yields on very safe assets, which also tend to be very liquid: Below "normal" yield-risk relation

- $y^{Corporate\ bond} - y^{Treasury} = \underbrace{v_T'(T)}_{\text{Treasury conv. yield}} + \underbrace{\text{Default component}}_{\text{Spread for large Treasury supply}}$

Evidence for a Treasury convenience yield, Krishnamurthy and V-J (2012)

Prediction: If $y^{Corp.\ bonds} - y^{Treasury}$ has a Treasury convenience yield component, then it should narrow with Treasury supply

Convenience yield on Treasuries – empirical test



- $y^{Corporate\ bond} - y^{Treasury}$
  $= \underbrace{v_T'(T)}_{\substack{\text{Treasury} \\ \text{conv. yield}}} + \underbrace{\text{Default component}}_{\substack{\text{Spread for large} \\ \text{Treasury supply}}}$
- Default component: Asymptote
  Conv. yield: Distance to asymptote
- Avg. $v_T'(T)$,1919-2008, long maturities:
  46 bps relative to Aaa corp. bonds
  73 bps relative to Baa corp. bonds

Did QE affect the Treasury convenience yield? Krishnamurthy and V-J (2011, 2013)

Event study of yield changes around QE announcement dates:

$$y^{Treasury} = Exp.\ avg.short\ rate + Duration\ risk\ comp. - v_T'(T)$$
$$y^{Corporate\ bond} = Exp.\ avg.short\ rate + Duration\ risk\ comp. + Default\ risk\ comp.$$
$$y^{MBS} = Exp.\ avg.short\ rate + Duration\ risk\ comp. + Prepayment\ risk\ comp.$$

Data: Yields, Federal funds futures, corporate CDS rates → Can back out the red terms

Of particular interest: Relative role of

- General channels: $Exp.\ avg.short\ rate + Duration\ risk\ comp$
- Specific channels: $v_T'(T)$, $Default\ risk\ comp$, $Prepayment\ risk\ comp.$
- If specific channels are important, then it matters what the central bank purchases

Did QE affect the Treasury convenience yield? Krishnamurthy and V-J (2011, 2013)

Event study of set of US QE announcement dates, 1 or 2-day yield changes:

	QE1	QE2	QE3
Type of asset purchase announced	MBS & Treasury	Treasury only	MBS only
Treasury Yields	Basis points		
10-year	-107	-18	-3
Corporate bonds (around 10yr duration)			
Aaa	-77	-9	4
Baa	-81	-7	0
Aaa CDS	-7	2	
Baa CDS	-40	2	
IG CDS			0
Agency MBS (around 10yr duration)			
30-year	-107	-12	-15
Fed Funds Futures			
24th month	-40	-11	-3
Implied signaling effect			
10-year	-20	-12	-1

QE1:

$y^{Corporate\ bond}\downarrow$ 81 bps

- Baa CDS ↓ 40 bps
- $Exp.\ avg.short\ rate + Dur.risk\ comp.\downarrow$ 41 bps, mostly from exp. avg. short rate (20-40 bps)

$y^{Treasury}\downarrow$ 107 bps

→ $v_T'(T)\uparrow$ 107-41=66 bps

$y^{MBS}\downarrow$ 107 bps

→ $Prepayment\ risk\ comp.\downarrow$ 107-41=66 bps

Did QE affect the Treasury convenience yield? Krishnamurthy and V-J (2011, 2013)

Type of asset purchase announced	QE1 MBS & Treasury	QE2 Treasury only	QE3 MBS only
Treasury Yields		Basis points	
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Agency MBS (around 10yr duration)			
30-year	-107	-12	-15
Fed Funds Futures			
24th month	-40	-11	-3
Implied signaling effect			
10-year	-20	-12	-1

QE2: $y^{Treasury}\downarrow$ more than other yields

Likely due to $v_T'(T)\uparrow$

QE3: $y^{MBS}\downarrow$ more than other yields

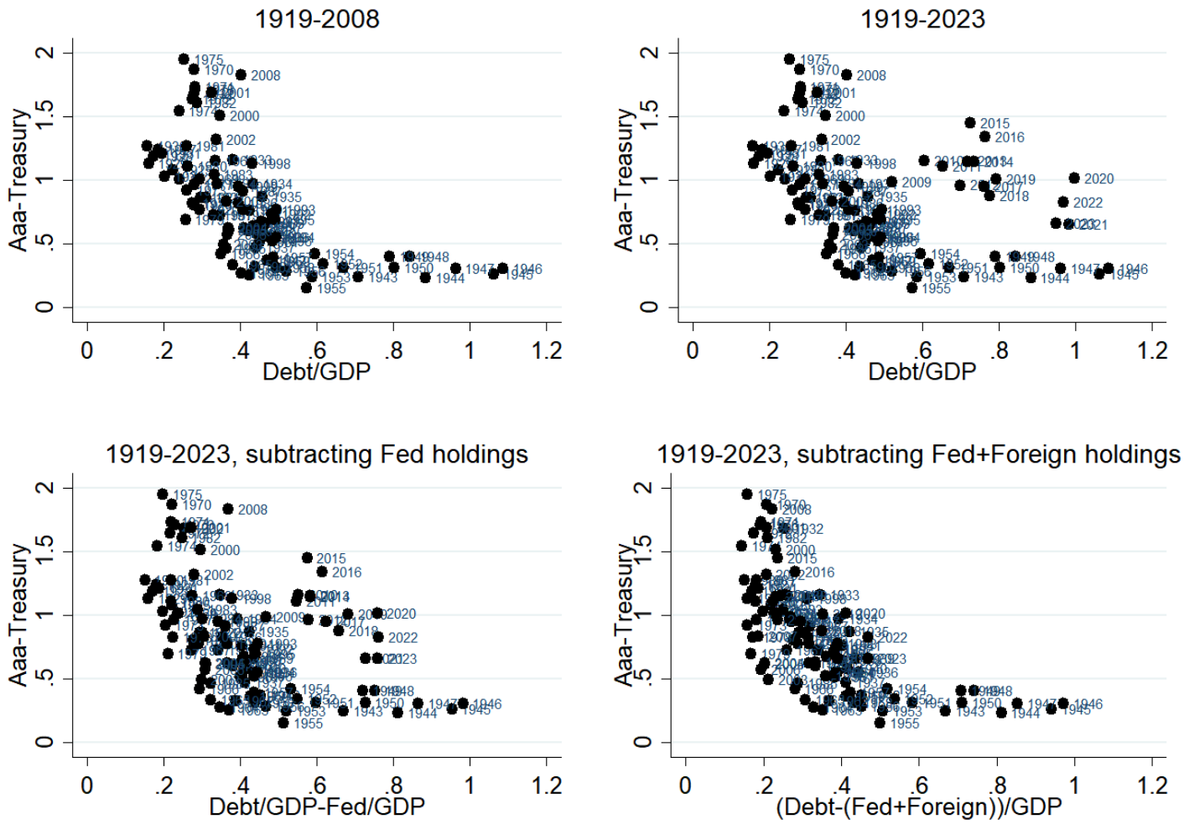
Likely due to $Prepayment\ risk\ comp.\downarrow$

Consistent message across QE1/QE2/QE3:

- Specific channels matter
- For lowering private sector yields, buying Treasuries is not the most effective (per dollar bought)

Did QE affect the Treasury convenience yield? Vissing-Jorgensen (2023)

Prediction: If Treasury QE affects Treasury conv. yield, Treasury demand shifts right



Top left: 1919-2008
Top right: 1919-2023

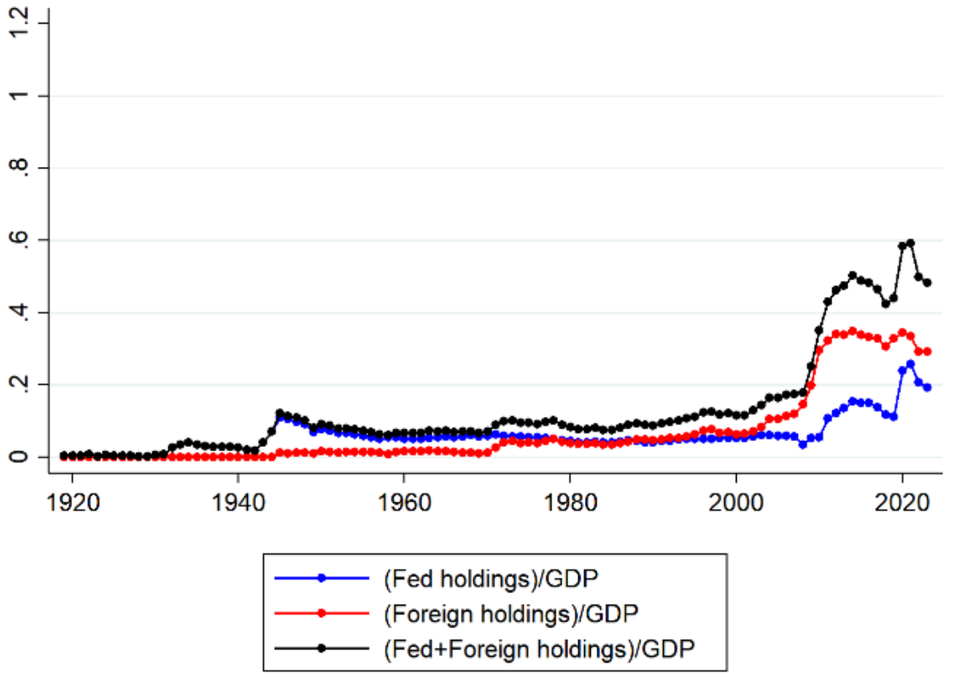
Outward shift post-GFC was due to Fed & foreign demand shocks:

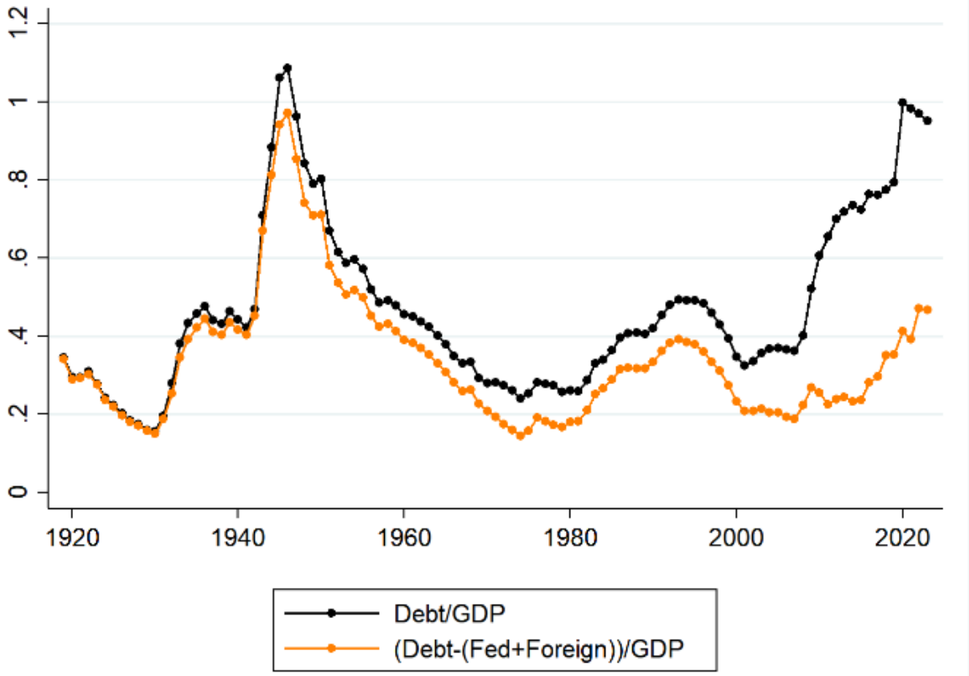
Bottom left: Role of Fed demand shocks
Bottom right: Role of foreign demand shocks

Did QE affect the Treasury convenience yield? Vissing-Jorgensen (2023)

Treasury holdings of Federal Reserve and foreigners

Annual data, 2019-2023





A CONVENIENCE-MAXIMIZATION PERSPECTIVE ON QUANTITATIVE TIGHTENING

Vissing-Jorgensen (2023)

Factors relevant for choosing balance sheet size when the short rate is above the ELB

How large should a central bank balance sheet be when a large balance sheet is not needed to stimulate the economy (ELB is not binding)? Considerations:

(a) Interest rate volatility: Lopez-Salido and Vissing-Jorgensen (2023) → Large balance sheet

- Several other considerations may point toward a smaller optimal balance sheet when the balance sheet is not needed for stimulus purposes

(b) Central bank's convenience (liquidity/safety) supply: Vissing-Jorgensen (2023)

- CB faces convenience supply tradeoff when supplying more reserves:
  - Adding convenience via reserves
  - Subtracting convenience via other assets if CB buys convenient assets
    Asset scarcity (US, Euro Area, UK,…)

Factors relevant for choosing balance sheet size when the short rate is above the ELB

(c) Side effects of large central bank balance sheets: Banks need to fund the reserve holdings

- Crowding-out of bank securities holdings/loans: Can lead to a welfare loss
- Crowding-in of deposits/other liabilities: Adds convenience benefits but also fin. stab. risk

(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

A simple framework for convenience-maximization

Private (non-central bank) sector's convenience from reserves and bonds with conv. yield:

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

Result (Convenience-maximizing reserve supply)

(A) If a central bank holds assets without convenience yields, $B^{cb} = 0$*:*

$\underset{R}{\text{Max}}\ v_R(R) - \varphi R \quad \rightarrow \mathrm{R}^{\mathrm{A}}$, *solves* $\quad v_R'(R) - \varphi = 0$

(B) If a central bank holds bonds (B) with convenience yields, $B^{cb} = R + A$*:*

$\underset{R}{\text{Max}}\ [\, v_R(R) - \varphi R\,] + v_B(B - R - A) \quad \rightarrow \mathrm{R}^{\mathrm{B}}$ *solves:* $\quad v_R'(R) - \varphi = v_B'(B - R - A)$

Holds regardless of the exact mix of crowding out/crowding in that banks use to fund reserves

A simple framework for convenience-maximization

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

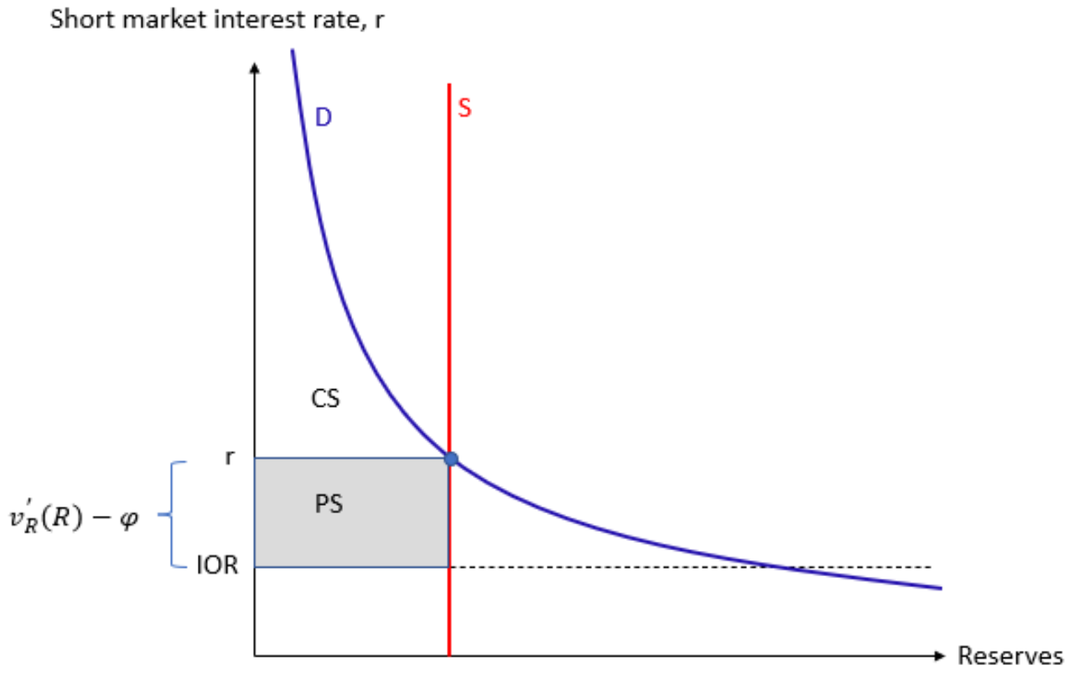
- Set $v_R'(R) - \varphi$ = *Average* convenience yield on ECB assets
- Suppose only German bunds have convenience yield

$$v_R'(R) - \varphi = \underbrace{v_B'\left(B_1^{priv}\right)}_{\text{Convenience yield on bunds}} * \underbrace{\omega}_{\substack{\text{ECB portfolio weight} \\ \text{on bonds}}} * \underbrace{\alpha_1}_{\substack{\text{Weight of bunds} \\ \text{in ECB's government} \\ \text{bond portfolio}}}$$

A simple framework for convenience-maximization: Case A

Reserve market

$$D: \quad r = IOR + v_R'(R) - \varphi$$



Total convenience value of reserves:

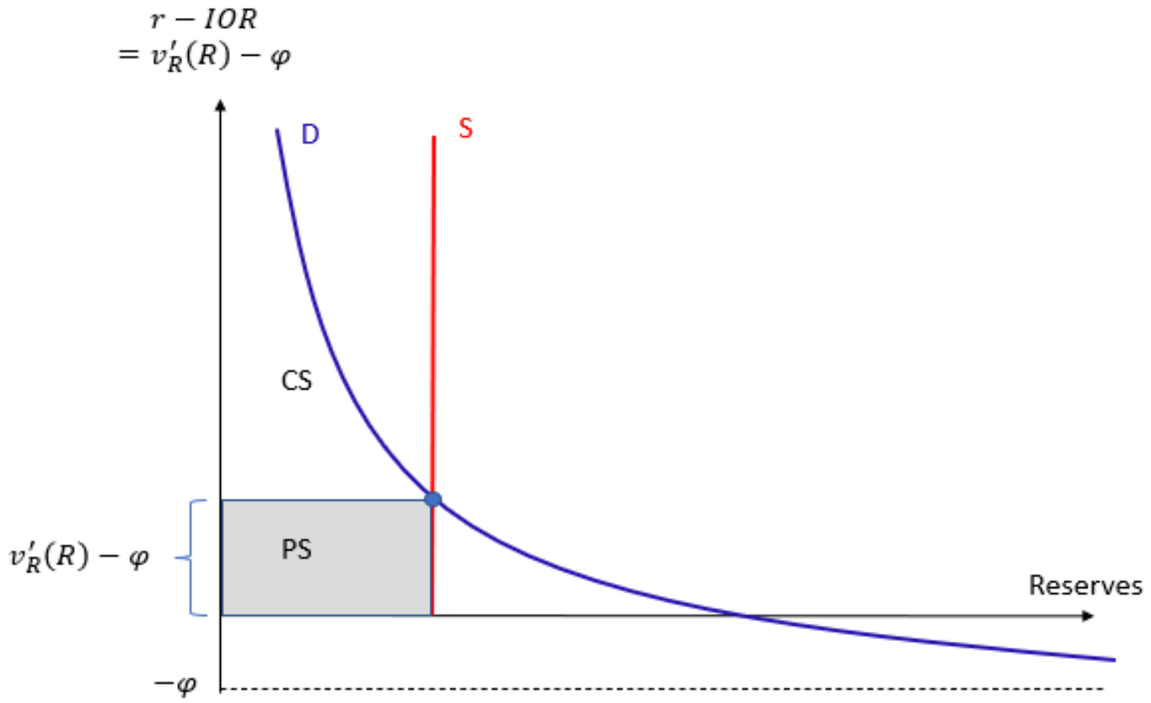
- Area between reserve demand curve and IOR, integral of $v_R'(R) - \varphi$
- For given unit of reserves

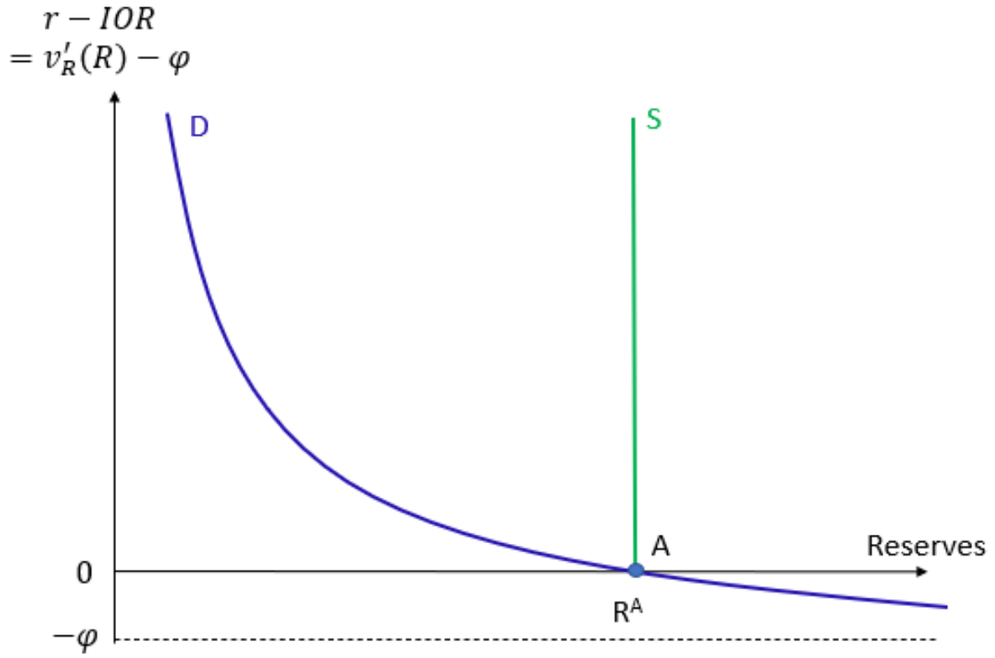
  Consumers' surplus (CS): $[IOR + v_R'(R) - \varphi] - r$

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

  Sum: $v_R'(R) - \varphi$

A simple framework for convenience-maximization: Case A



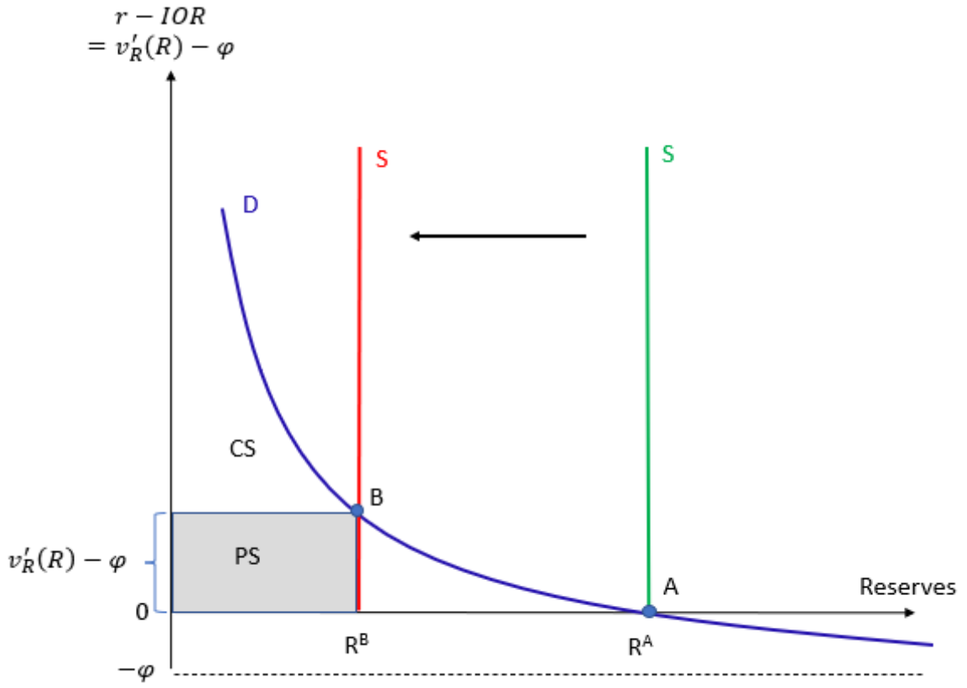


- R^A maximizes CS+PS from reserves by setting $v'_R(R) - \varphi = 0$

A simple framework for convenience-maximization: Case B

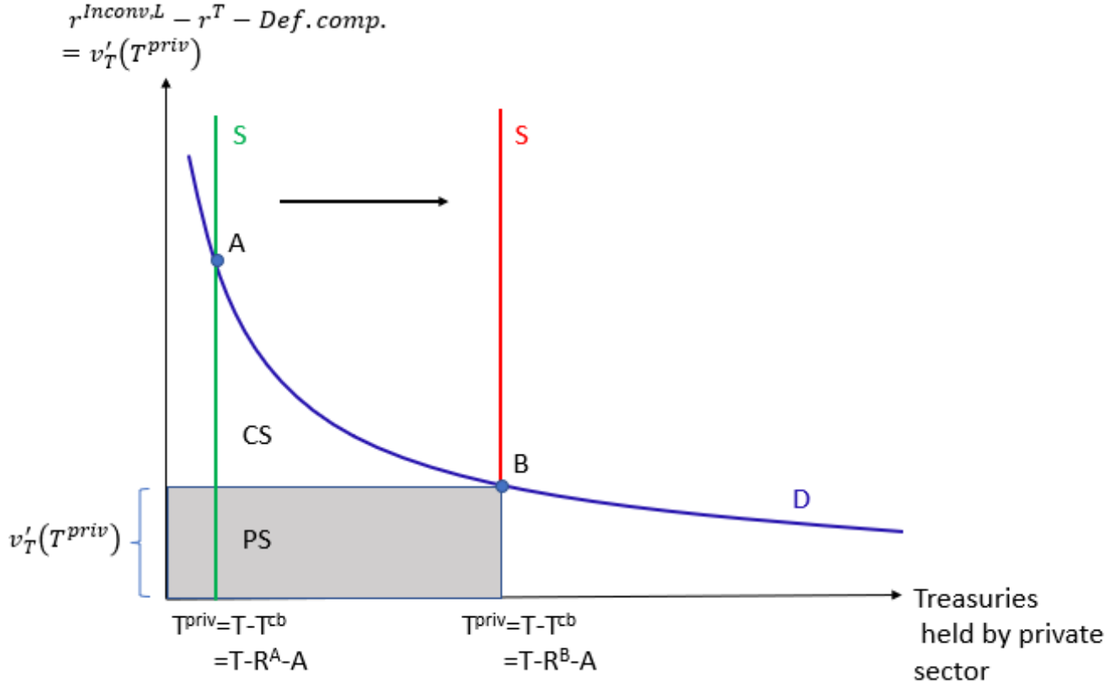
Reserve market

D: $r - IOR = v_R'(R) - \varphi$



Bond market (e.g., Treasuries)

D: $r^{Inconv,L} - r^T - Def.comp. = v_T'(T^{priv})$



- R^B maximizes total CS+PS from reserves and bonds: Set $v_R'(R) - \varphi = v_T'(T^{priv})$

A simple framework for convenience-maximization: The politics of CB assets

- From a convenience supply perspective: Preferable to be in Case A
- Smaller convenience-maximizing balance sheet size in Case B
  - But CB asset choice driven by politics, not convenience maximization
  - Across the Atlantic: What is politically sensitive differs

A simple framework for convenience-maximization: The politics of CB assets

Federal Reserve: Has announced plans to primarily hold Treasuries in the longer run (Case B)
"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/guaranteed by, the US
  Corporate bond purchases during COVID: Emergency 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 (not even govt. guaranteed MBS)

  "…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"

A simple framework for convenience-maximization: The politics of CB assets

ECB: Could likely hold only assets without convenience yields in the longer run (Case A)
(and without requiring convenient assets as collateral for lending)

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

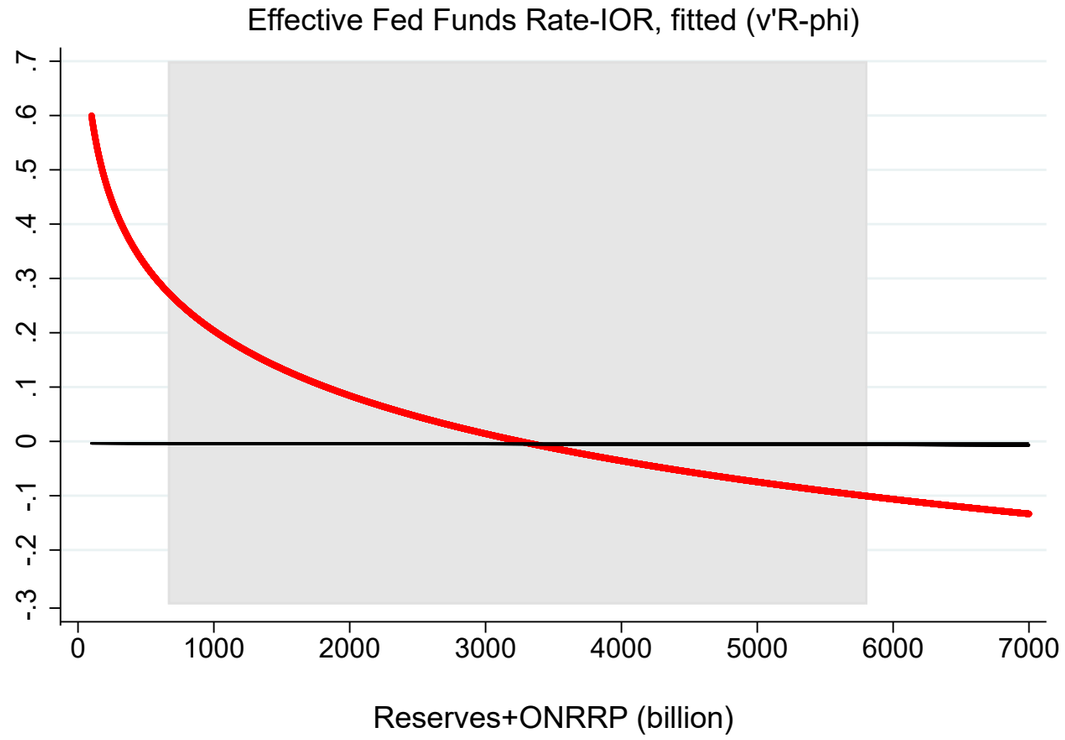
  "In the euro area, however, there are […] additional considerations relevant for the assessment of whether a large bond portfolio is desirable or not. One is that the lack of a consolidated public sector balance sheet raises more fundamental concerns about monetary and fiscal interactions in a currency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

Implementing the convenience-maximation framework: US, case A

Case A: Follows from reserve demand estimation in LSVJ, $r - IOR = v_R'(R) - \varphi$

$$EFFR - IOR = \hat{A} + \hat{B} * ln(Res + ONRRP) + \hat{C} * ln(Deposits)$$

April 2023:

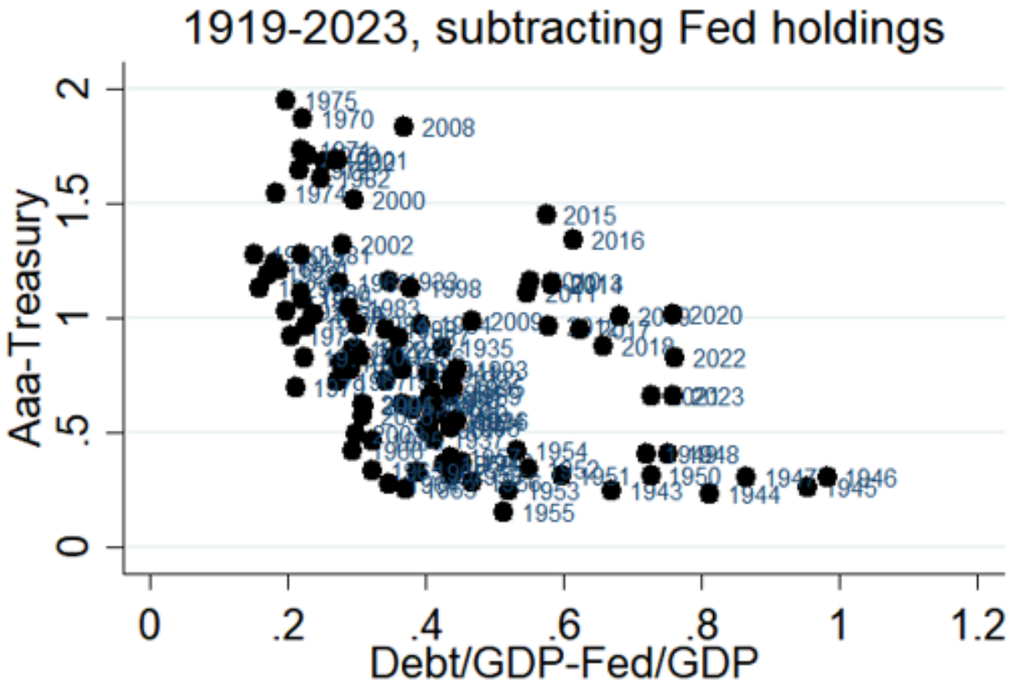


- Red line: Fitted $v_R'(.) - \varphi$ using deposits of $17.258T for April 2023
- $v_R'(.) - \varphi = 0$: Reserve+ONRRP=$3.285
- A bit larger than the value that sets predicted EFFR-IOR equal to same as in Sept 2019
- Conv. max. Reserves+ONRRP grows over time with deposits

Implementing the convenience-maximation framework: US, case B

Case B: Also need $v_T'\left(Treasuries^{Private}\right)$. Updating KVJ (2012)

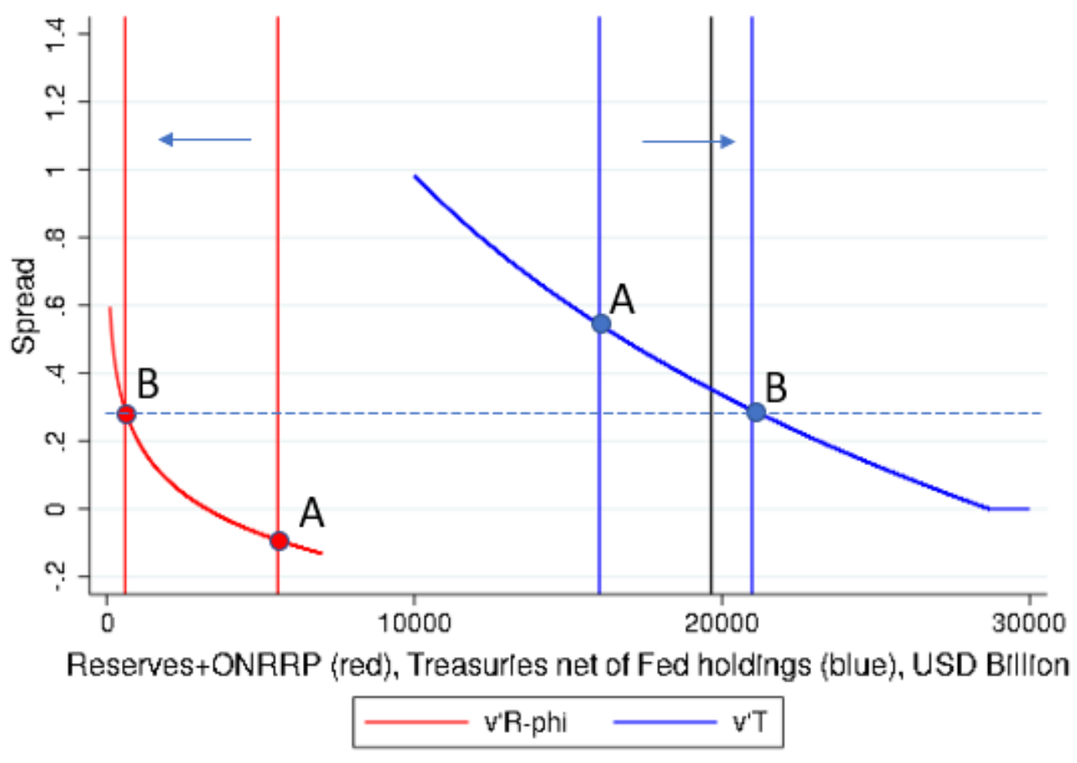
$$y^{Aaa} - y^{Treasury} = \max\left(A_T + B_T * ln\left(\frac{Treasuries^{Private}}{GDP}\right) + \sum_{i=2009}^{2023} \beta_i D(year = i), C_T\right) + U$$



- $\frac{Treasuries^{Private}}{GDP} = \frac{Debt}{GDP} - \frac{Fed}{GDP}$
- Annual data for 1919-2023
- Year dummies for 2009-2023: Capture rightward shift post-GFC (due to foreigners)
- Max: Accounts for Treasury demand saturation
- C_T: Estimated default component

Implementing the convenience-maximation framework: US, case B

April 2023:



Reserves+ONRRP, Treasuries held by private sector

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

- Red: $v_R'(.) - \varphi$ given current deposits
- Blue: $v_T'\left(\frac{Treas.^{Private}}{GDP}\right)$ 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

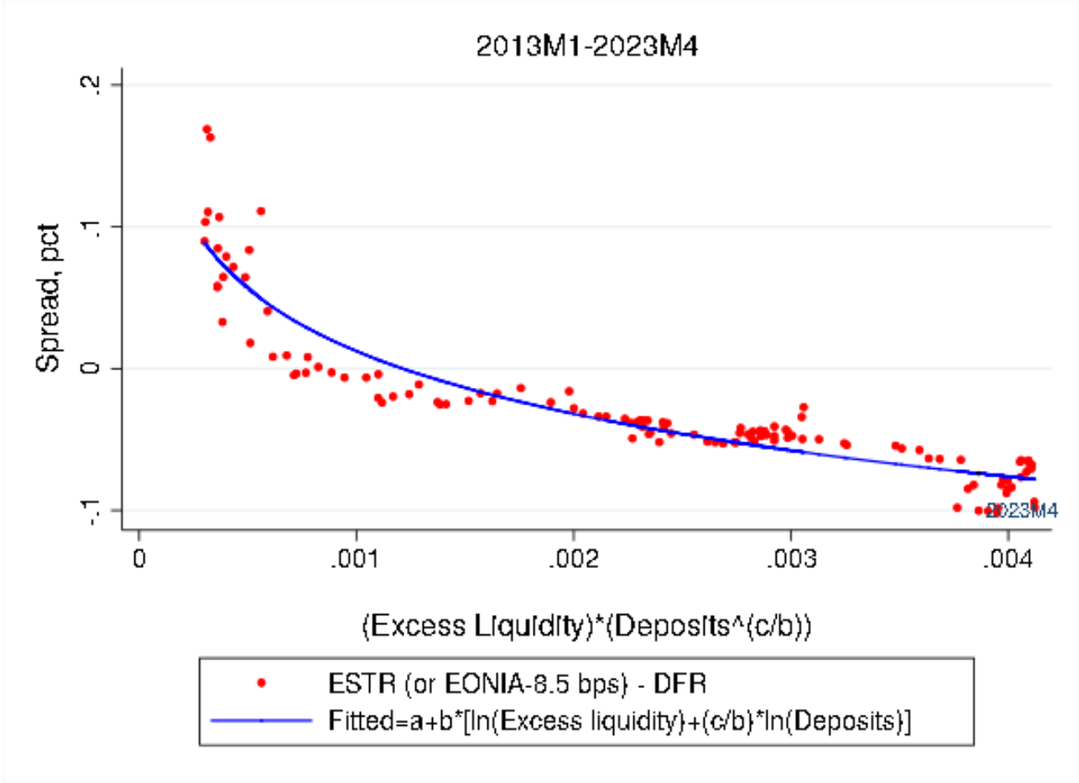
Convenience yields equalize at 29 bps

Reserves+ONRRP=$593B

Implementing the convenience-maximation framework: Euro area, case A

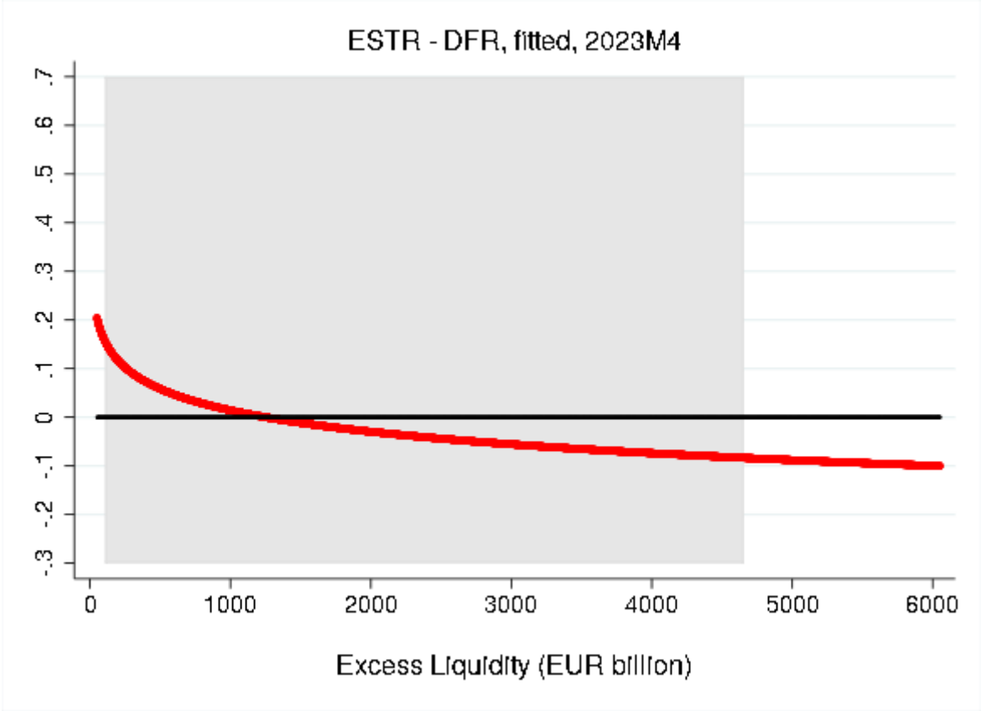
Case A: Redo reserve demand estimation in LSVJ, $r - IOR = v_R'(R) - \varphi$

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



- Excess liquidity (excess reserves)
  = Current accounts + Deposit facility
  - 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

Implementing the convenience-maximation framework: Euro area, case A



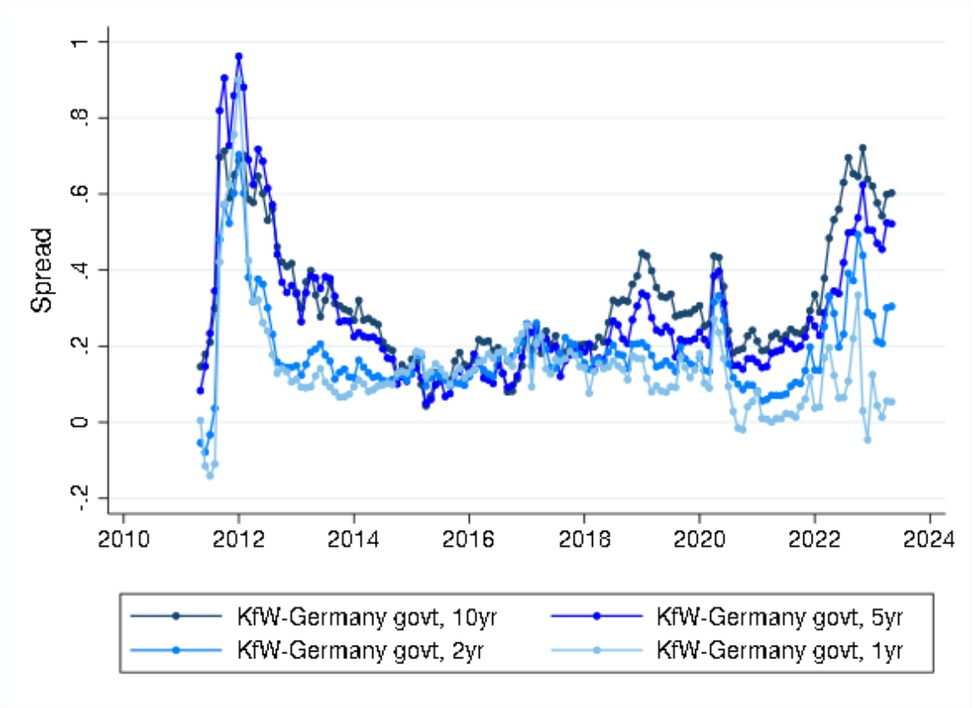
Gray shaded area: Range of data used in estimation

- Red line: Fitted $v_R'(.) - \varphi$ using overnight deposits for April 2023: € 9.4T
- $v_R'(.) - \varphi = 0$: Excess liquidity = € 1.251T
  + Required reserves € 165B
  Liquidity = € 1.416T
- Conv. max. liquidity grows over time with deposits

Implementing the convenience-maximation framework: Euro area, case B

Simple attempt: Suppose ECB supplied reserves via govt. bonds ($\omega = 1$), in proportion to capital key (Germany: α_1 =0.214) and only German Bunds (B_1) have convenience yields

Spreads on government bonds: Germany



- Measure Bund conv. yield by KfW - Bund spread
  April 2023: 10-year maturity: 60 bps
  2-year maturity: 30 bps

- $v_R'(R) - \varphi = \underbrace{v_B'\left(B_1^{priv}\right)}_{\text{Around 40 bps}} * \underbrace{\omega}_{=1} * \underbrace{\alpha_1}_{=0.214}$

  $\text{will fall as } B_1^{priv} \uparrow$

$\rightarrow$ $v_R'(R^B) - \varphi \leq 8\ bps \rightarrow$ Liquidity ≥ €521B, < €1.4T

Conclusions about the role of convenience yields in central bank policy

1. Convenience yield on cash, government deposits:
   - Central banks supply these liabilities elastically (at prevailing *r*): Payments objective
2. Convenience yield on reserves: Shapes reserve demand
   - Interest rate control: How to set the interest rate on reserves such that short market rates clear near the target
   - Quantitative tightening: When will interest rate volatility increase?
3. Convenience yield on Treasuries: Shapes Treasury demand
   - Quantitative easing: Not all interest rates move the same with QE
     → It matters what type of assets the central bank buys!
4. Equalizing convenience yields on reserves and Treasuries
   - A convenience-maximization perspective on quantitative tightening
   - Natural extension of CBs payment objective

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