Lecture notes on money, finance, risk management, and public policy

Central banks in the global financial crisis and after

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Central bank response to the global financial crisis

The debate on unconventional monetary policy

The attempt at normalization of monetary policy after the crisis

The coronavirus crisis and after

Evolution of monetary policy frameworks

Central bank response to the global financial crisis

- Emergence of the central bank crisis response
- Growth of the Fed's balance sheet
- Forward guidance
- Conflicts in the Fed's crisis response

The debate on unconventional monetary policy

The attempt at normalization of monetary policy after the crisis

The coronavirus crisis and after

Evolution of monetary policy frameworks

Unconventional monetary policy tools

Some new, most adaptations of traditional tools:

Target short-term interest rate reduction to zero or negative levels

Balance sheet expansion to lower long-term rates

Lending operations to banks and other counterparties

Outright purchases of long-term securities, primarily bonds, but also equities

Communication to lower *expected* path of future short-term rates

- **Forward guidance**: communication about future monetary policy

Administered rates and standing facilities to maintain control of short-term rates rate

- Counteract potential for more drastic loosening of monetary stance than intended
- **Interest on excess reserves** (IOER) paid to banks from 06Oct2008
- Now called **interest on reserve balances** (IORB)

Overlapping stages of Federal Reserve action

Traditional tools and communication beginning Aug. 10, 2007

- Fed very cautious about expansionary monetary policy until late 2008
- Rate cuts beginning 18Sep2008, by 50 bps to 4.75 percent
- Communication:
  - 16Dec2008: "exceptionally low levels...for some time"
  - 18Mar2009: "for an extended period"

Emergency lending programs to support systemically-important intermediaries, infrastructures

- Balance sheet does not expand initially
- But composition change→nontraditional assets (credit policy)

Unconventional monetary policy from late 2008

Zero interest-rate policy (ZIRP): **effective lower bound** reached 16Dec2008

- Target funds rate 0–25 bps

Large-Scale Asset Purchases (LSAPs) from early 2009

- Expansion of balance sheet
- Aka **quantitative easing** (QE)

Earliest Federal Reserve actions

Unusual press release does not announce any actual change:

Release Date: August 10, 2007

For immediate release

The Federal Reserve is providing liquidity to facilitate the orderly functioning of financial markets.

The Federal Reserve will provide reserves as necessary through open market operations to promote trading in the federal funds market at rates close to the Federal Open Market Committee's target rate of 5-1/4 percent. In current circumstances, depository institutions may experience unusual funding needs because of dislocations in money and credit markets. As always, the discount window is available as a source of funding.

OMOs unusual in several respects:

- At several nonstandard times of day, including afternoon operation
- Accepted collateral included MBS but not Treasuries
- Large total amount accepted in the course of the day

Deal Date	Op Type	Auction Method	Settlement	Op Close	MBS-Submit	MBS-Accept	MBS-Stop-Out	MBS-Wght Avg	MBS-High	MBS-Low
8/10/2007	RP	Multiple Price	Same Day	1:50 PM	11	3	5.1	5.127	5.25	3.5
8/10/2007	RP	Multiple Price	Same Day	10:55 AM	40.95	16	5.25	5.266	5.35	4.5
8/10/2007	RP	Multiple Price	Same Day	8:25 AM	31.2	19	5.15	5.236	5.35	4

Federal Reserve emergency lending programs

Term Auction Facility (TAF) 12Dec2007: banks' funding liquidity problems

Currency swap lines 12Dec2007: foreign banks' dollar funding liquidity

Term Securities Lending Facility (TSLF) 11Mar2008: shortages of good collateral

Primary Dealer Credit Facility (PDCF) 16Mar2008: discount window for primary dealers

Maiden Lane 24Mar2008: financing of Morgan acquisition of Bear

Maiden Lane II and III 16Sep2008: rescue of AIG

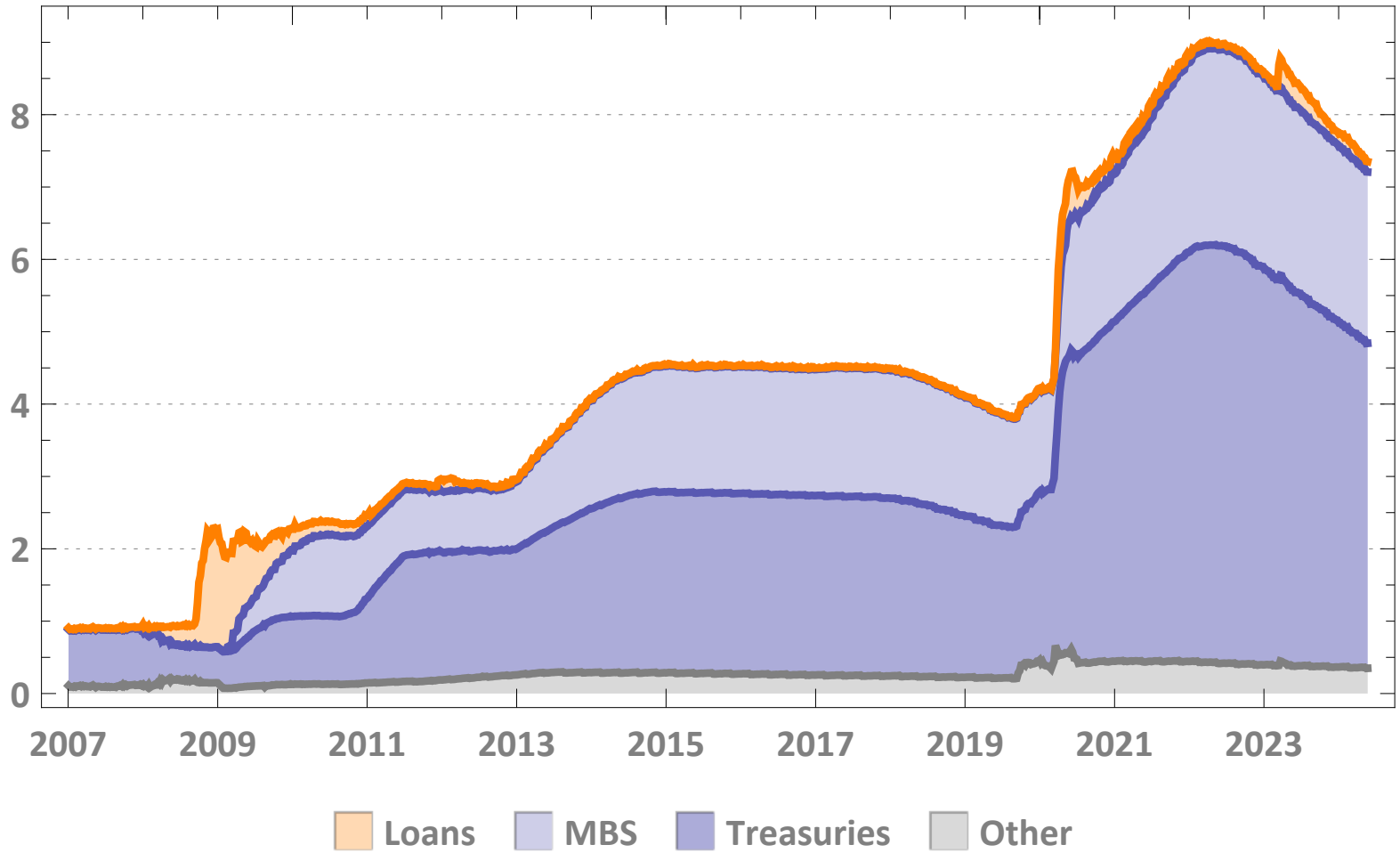
ABCP Money Market Mutual Fund Liquidity Facility (AMLF) 22Sep2008: run on ABCP

Commercial Paper Funding Facility (CPFF) 07Oct2008: CP liquidity

Money Market Investor Funding Facility (MMIFF) 21Oct2008: run on MMMFs

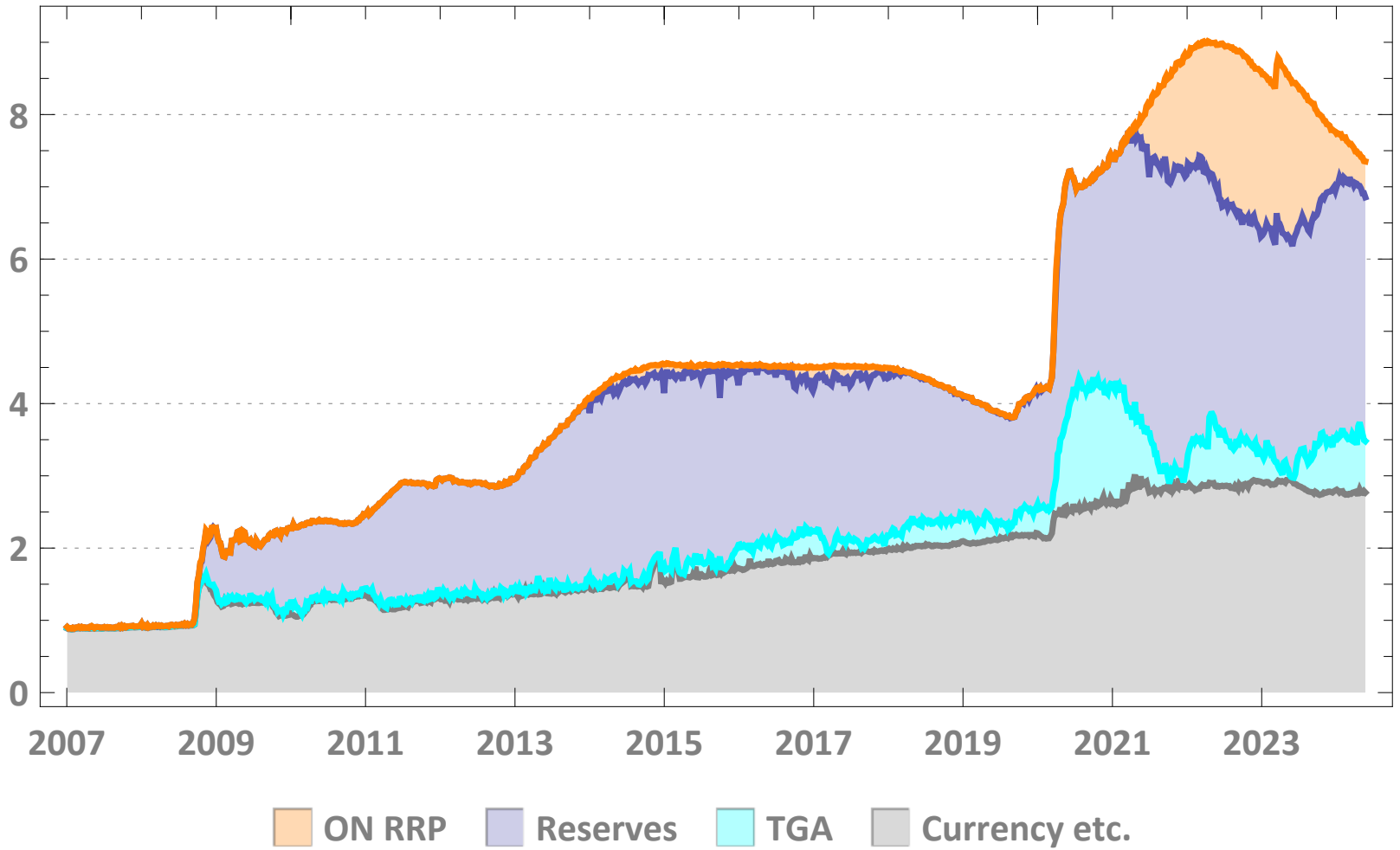
Term Asset-Backed Securities Lending Facility (TALF) 25Nov2008: sudden stop in securitization

Federal Reserve assets 2007–24



Loans include primary and secondary discount window lending, emergency liquidity facilities, and central bank liquidity swaps. Other assets include gold and unamortized discounts on Treasury and agency securities. $ trill., weekly (Wednesdays), 03Jan2007 to 22May2024. *Source*: Federal Reserve Board, H.4.1 release.

Federal Reserve liabilities 2007–24



Currency etc. includes reverse repo transactions conducted as an investment service with foreign official and international accounts. $ trill., weekly (Wednesdays), 03Jan2007 to 22May2024. *Source*: Federal Reserve Board, H.4.1 release.

Evolution of the LSAPs

LSAP1 announced 25Nov2008, ended Mar. 2010 ("QE1")

- 05Jan2009: purchases of agency and MBS commence
- 18Mar2009: increase in size and expansion to Treasuries
- 10Aug2010: reinvestment of MBS prepayments in Treasuries

LSAP2 announced 03Nov2010, ended Dec. 2012 ("QE2")

Maturity Extension Program (MEP) or "Operation Twist"

- 21Sep2011: purchase long-, sell short-term Treasuries
- reinvestment of MBS prepayments in MBS
- 20Jun2012: extended through end-2012

Flow-based asset purchases: no total amount or termination date specified (LSAP3, "QE3" or "QE∞")

- 13Sep2012: \$40 bill. MBS/mo.
- 12Dec2012: addition of \$45 bill. Treasuries/mo.
- 18Dec2013: **tapering** announcement
  - Purchases gradually reduced from Jan. 2014
- Oct. 2014: end of program (but reinvestment continues)

New elements of communication

- Communication challenges:
  - mitigate time inconsistency
- **Forward guidance**: communication about future monetary policy
  - Commitment to keep target short-term rate low in the future
  - Unconventional policy may lack credibility
  - If successful, expected path of short-term rates lower↔lower long-term rates than otherwise
- Communication as an easing tool↔align expectations with balance-sheet and rates policies
  - Forward guidance and LSAPs are distinct tools, latter can be dialed down while extending former
  - Also to maintain asset purchases, size of central bank balance sheet
- **Summary of Economic Projections** (SEP) since 27Apr2011
- Quarterly press conference
- 24Jan2012: *Statement on Longer-Run Goals and Monetary Policy Strategy*
- Formal public statement summarizing monetary policy objectives and overall approach to operations

Types of forward guidance

Qualitative: the pre-crisis norm

- General statements of intention contingent on future market conditions ("data-dependent")
- Reintroduced 19Mar2014 ("for a considerable time after...") and modified 17Dec2014 ("can be patient...")
- Can be consistent with discretionary or rules-based policy

Calendar-based: introduced 09Aug2011 ("at least through mid-2013")

- Persuade public that accommodation to remain even after normal policy would have tightened
- Extended 25Jan2012 ("at least through late 2014")
- And again 13Sep2012 ("at least through mid-2015")

Threshold-based or **state-contingent:** introduced 12Dec2012 ("at least as long as the unemployment rate remains above 6-1/2 percent")

- Modified 12Dec2013 ("well past the time... unemployment rate...below 6-1/2 percent")
- Return to qualitative 19Mar2014
- E.g. Draghi 26Jul2012: "ready to do whatever it takes"

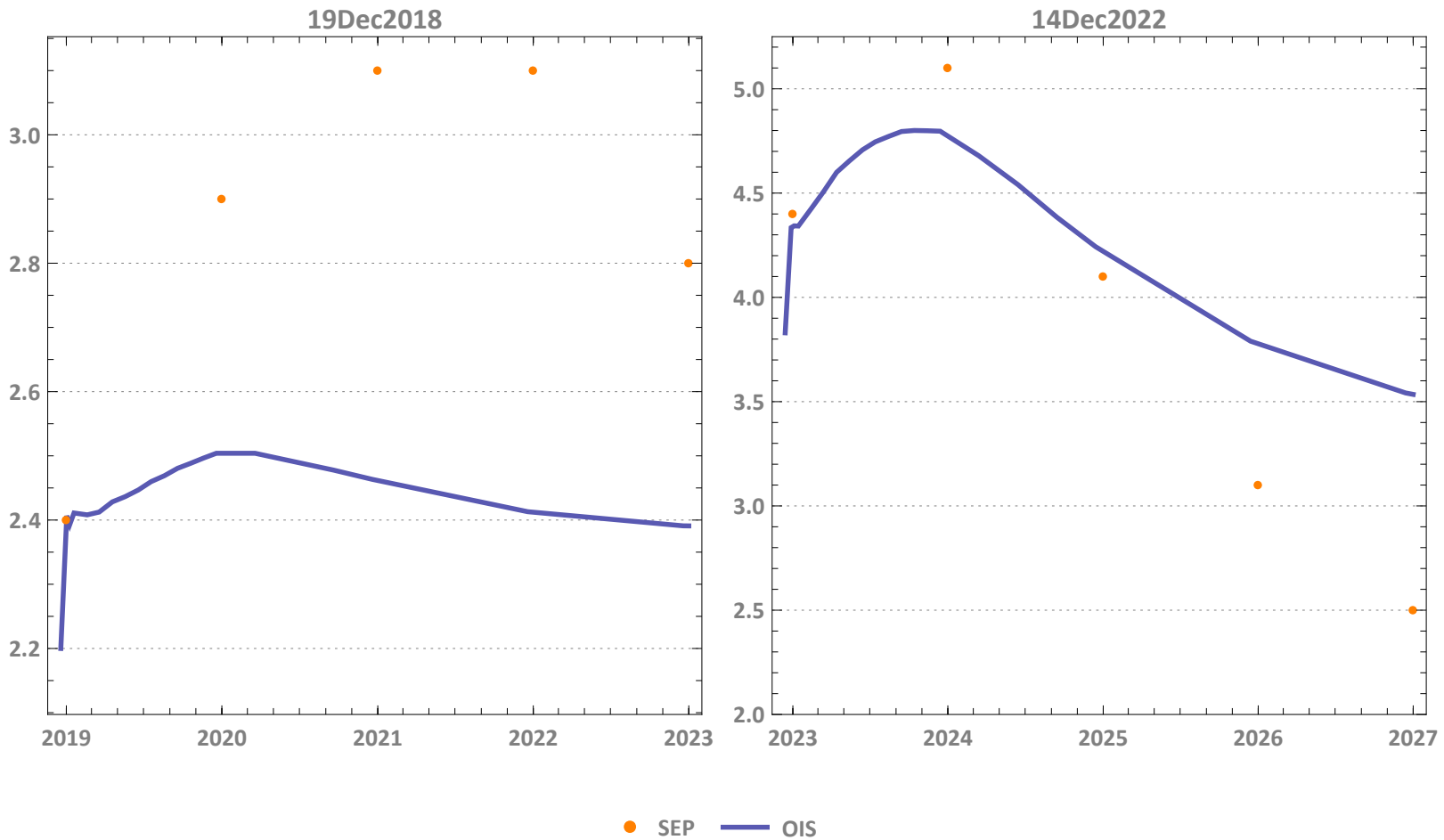
Communication challenges and the "dots plot"

- Gap between market, policymaker views may represent lesser/greater pessimism in market than on FOMC

  "Delphic" communication of central bank economic outlook avoids time inconsistency

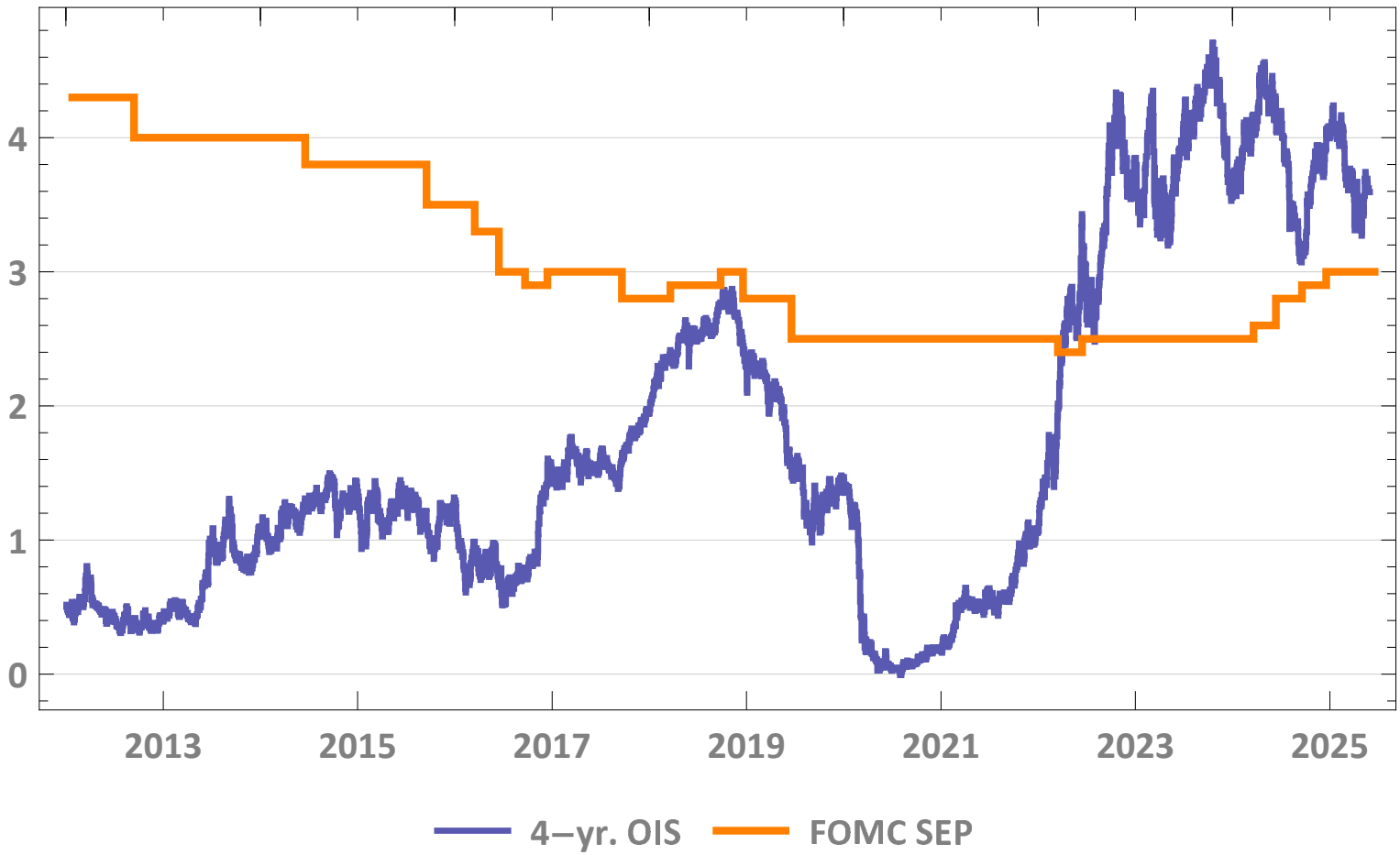
  "Odyssean" commitment to extraordinary accommodation regardless of
  - Improvement to outlook
  - Departure from conventional policy tools
  - Calendar- and threshold-based
- SEP since 2012 includes projections of fed funds rate over next 4-5 years
- "Dots plot" shows gap between market and FOMC projections of funds rate at different horizons
- Gap has narrowed considerably: 4- and 5-year OIS swap rates now 2.7 percent, close to median longer-run funds rate projection

Dots plot



Purple markers: medians of FOMC participants' projections of future Fed funds rate. SEP data available at . Orange plot: forward overnight rates (OIS curves) on the date of the SEP realease. *Sources*: `http://www.federalreserve.gov/monetarypolicy/fomccalendars.htm`, Bloomberg LP

Market and FOMC expectations 2012–2025



Purple plot: median of FOMC participants' projections of longer run Fed funds rate from quarterly Summary of Economic Projections (SEP); *source*: FRED, series FEDTARMDLR, Q1 2012 to Q1 2025. Orange plot: fixed rates on 4-year OIS swaps (4-year forward overnight rates), daily, 03Jan2012 to 27May2025; *source*: Bloomberg LP.

Emergency liquidity versus monetary policy

- Initial response to crisis in capacity of lender of last resort
- Focus on dislocations in money markets, e.g.
  - Difficulty sourcing high-quality collateral→fails, repo rates → 0
  - Reluctance of commercial banks to lend to one another→spikes in interbank rates and term spreads
- Fed addresses liquidity via variants on normal operations
  - E.g., TSLF: primary dealers can swap agency debt, agency and AAA non-agency MBS for "best collateral," Treasury securities
  - Provision of liquidity to market, not individual firms
  - Bear Stearns: first program supporting individual firm
- How drastically loosen liquidity policy without loosening monetary policy?
  - ↔How keep bank reserves constant while supporting liquidity?
- Reserves and balance sheet initially (Dec07–Sep08) constant
  - Fed changes composition of *assets* on its balance sheet
  - Sells T-bills, then bonds to offset emergency lending

Did the Fed follow Bagehot's Rule?

- Fed authority in Section 13(3) of Federal Reserve Act
  - Adopted 1932, amended 1935, 1991
  - "In unusual and exigent circumstances," secured lending permitted to any market participant
  - Limited by Dodd-Frank to "facility with broad-based eligibility"
- Critiques of Fed as lender of last resort:
  - Following no rules or implicit rules ($\rightarrow$TBTF, moral hazard)
  - Lending to insolvent intermediaries a Treasury function
  - Indirect taxpayer funding of bank recapitalization via IOR, reduces Treasury remittances
- Profits on Maiden Lanes$\Rightarrow$emergency credits liquidity, not credit provision or solvency relief; long-term value was there
- **Credit policy**:
  - E.g. MBS in LSAPs: supports key sector of economy, but also subsidizes housing

Zero bound: the rationale for unconventional policy

- The overarching policy dilemma:
  - Supporting the real economy and reducing unemployment
  - While gradually and safely deleveraging the financial system
- **Equilibrium** or **natural real interest rate** low or negative during severe recession
  - But low inflation expectations→market real rate positive, even rising
- Once conventional tools lower current short rate to near zero...
- ...short and long-term real interest rates stay stubbornly high
  - Short-term assets near-perfect substitutes
  - Normal monetary operations (e.g. purchase bills against reserves) ineffective
- Taylor rule no longer provides guidance
  - Estimate long-term nominal rate response to volume of bonds extracted from private investors by LSAPs
  - Clue to distance from "shadow" negative short-term rate needed to achieve mandate

Negative interest rates

- Negative rates *policy* rates: additional or alternative tool to quantitative easing
  - Implemented by central banks of euro zone, Denmark, Japan, Switzerland, Sweden
  - Includes smaller countries resisting currency appreciation
  - Never introduced by Federal Reserve
- Negative *market* rates: U.S. T-bills (sporadically), JGBs, Bunds
- Where is the **effective lower** or **zero bound** on nominal rates?
  - 2008–2021 levels exceptional historically
  - Short-term rates never this negative, longer-term rates never negative
- Limitations of negative policy rates:
  - **Demurrage:** cost of holding currency may be high, but finite
  - Bank depositor resistance inhibits banks from passing through costs of central bank reserves
  - Floating-rate contracts often bounded at zero
  - Impact on market functioning
- Policy mechanisms to reduce effective lower bound:
  - Time-stamped money, Silvio Gesell, Townsend Plan
  - Replace paper currency by electronic transactions

Helicopter money

- Idea introduced by Friedman (1960): money-financed fiscal policy
  - Proposed as a more-stimulative alternative to QE
  - Also called **overt monetary finance** (OMF)
- Central bank creates high-powered money, places it in hands of public
  - Permanent and irreversible, and expected by public to be so; money is nonredeemable
  - Increases government budget deficit
- Proceeds can be used to buy goods and services (i.e. spending) or for transfers ("helicopter drop")
- Problematic impact on central-bank independence
  - Offsetting central-bank asset: perpetual nonredeemable public debt
  - Transfer of any interest to Treasury
  - Fiscal policy: equivalent to QE plus a permanent tax cut
- Incompatible with interest-rate targeting framework
- Challenge of inflation expectations
  - Credible central bank: difficult to convince public of permanence
  - Less-credible central bank may increases expected inflation more than desired

Background: drivers of the long-term interest rate

- Long-term real rates crucial for recovery of real economy
  - Drive cost of funding for fixed investment (plants, equipment, residential investment) and stock market
  - Reduce loan-to-value (LTV) in commercial real-estate loans
- Nominal long-term rates can be decomposed two ways
  - Expected path of short-term rates plus a term risk premium
  - Fisher equation: real rate plus expected inflation plus an inflation risk premium
- To lower long-term real rate, *lower* expected path of short rates and term premium, and/or *raise* expected inflation

Debates on LSAP impact on real economy

- Impact on long-term rates: via which channels does it work?
- Identification problem: hard to trace market response back to monetary, regulatory, debt management policies
- Primary putative effect: via lower real yield curve
- Effectiveness of QE impaired by paying interest on reserves
  - Substitution of one form of government debt for another
- Impact on employment, real economy, realized and expected inflation: slow and low-growth recovery
- LSAPs may weaken growth
  - Banks and capital markets generally seek long-term assets to replace "lost" duration
  - Gravitate away from short-term lending (distinct from short-term lending in collateral markets)
  - Weak investment: large firms improve balance sheets, small business can't borrow

How could LSAPs affect the real economy?

Expected short rates may fall via **signaling effect**

- LSAPs enhance credibility of committment to hold rates low
  - Since Fed suffers balance-sheet losses if rates rise rapidly
- Fed suffers balance-sheet losses if rates rise rapidly
- Weak evidence of announcement-date effects
- But volatility of effective-target funds deviations falls sharply

Expected inflation may rise, reducing the real rate

- Post-2007: avert deflation or greater disinflation

Term premium may fall via **portfolio balance** or **preferred habitat channel:**

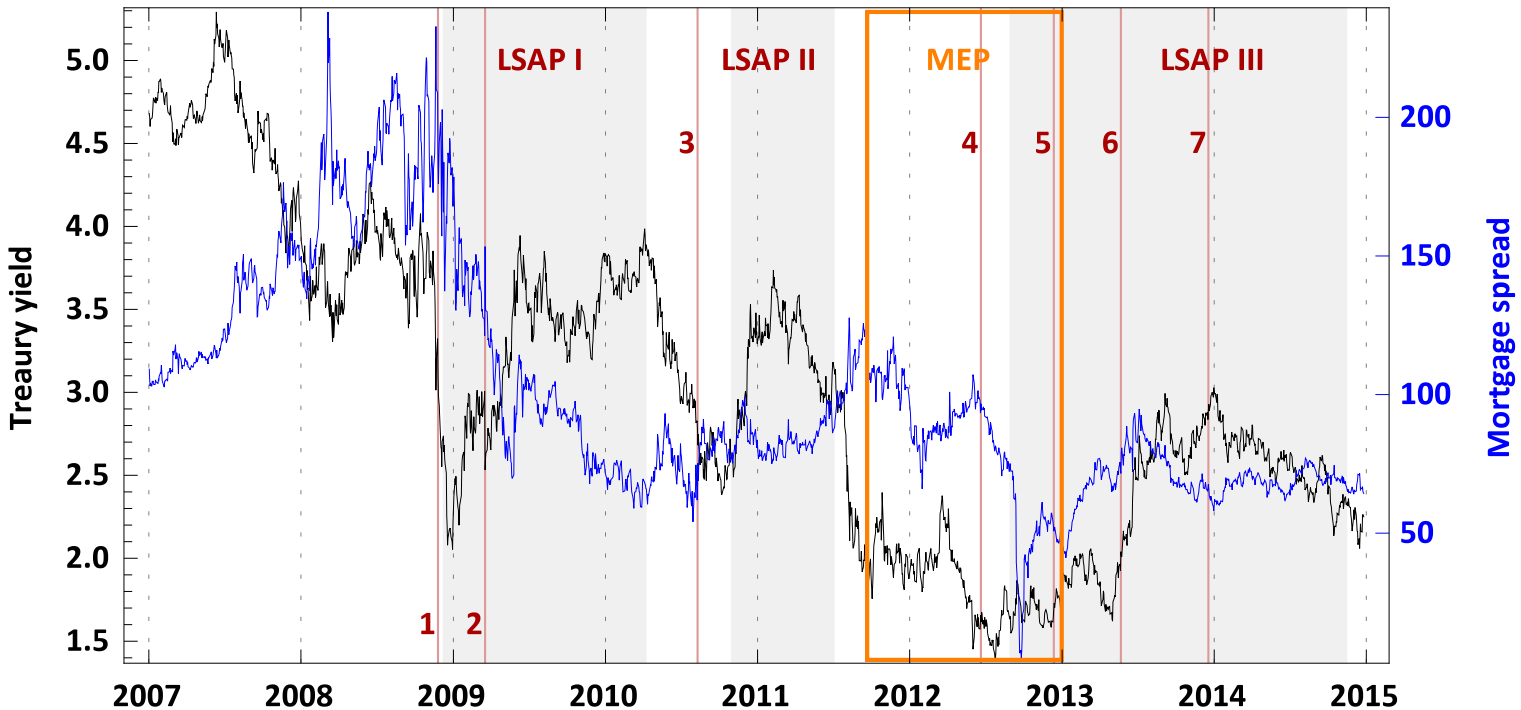
- Change composition of assets in private-sector hands
- QE and QT: change amount of interest rate risk borne by public
- Yields on risk-free bonds decline, asset prices buoyed, private net worth, balance sheets improve

Liquidity impact of increasing banks' reserves, withdrawing high-quality collateral from the market

Portfolio balance influence on term premium

- Some investors desire bonds with specific characteristics
- Limits arbitrage→ LSAPs reduce those bonds' risk premiums
- Induces substitution into bond types not purchased directly (e.g. corporate, MBS) as investors rebalance portfolios
- Analogous to "classical" channel of monetary policy: changing stock of money balances drives spending decisions
- **Duration channel:** LSAPs lower duration risk premium→lower yields/higher prices of all long-term bonds, possibly equities
- **Safety channel:** Treasury bonds risk-free, used as collateral
  - Scarcity of safer assets→riskier assets, e.g. equities, more attractive
  - But LSAPs may *widen* credit, **mortgage spread**, gap between MBS and Treasury yield
  - MBS purchases constrain mortgage spread
- Evidence that it was signaling, impact on expected inflation, not portfolio balance
  - Impact on long-term rates of the programs not persistent, has a "half-life"
  - But makes it possible to contemplate exit with large balance sheet

Impact of LSAPs on interest rates



Black plot (left axis), U.S. generic 10-year yield (USGG10YR Index, percent). Blue plot (right axis), current coupon FNMA 30-year mortgage rate (MTGEFNCL Index) spread over USGG10YR (bps). *Source*: Bloomberg LP. Shading: active periods of LSAPs. Grid lines:

1 LSAP I announcement
2 Expansion of LSAP I to Treasuries
3 Reinvestment of MBS principal in Treasuries
4 MEP extension through 2012
5 Expansion of LSAP III to Treasuries
6 Joint Economic Committee testimony
7 Tapering announcement

Risks of unconventional monetary policy

- Increase in monetary base→inflation risk
- Little historical experience with unconventional tools
- Distortive effects of effect of "low for long"
  - **Reaching for yield** and excessive risk-taking
  - Long-term investors, e.g. pension funds and insurance companies, under pressure
  - Reluctance to lend, esp. banks
- Difficulty of exit→exit strategy
- Open or covert credit policy
- Possibility of losses to Federal Reserve
  - Negative cash flow if rapid rise in short-term rates requires increase in IORB with large quantity of low-coupon assets
  - Mark-to-market losses on portfolio
  - Realized losses if (→)exit strategy amended to include sales of low-coupon bonds in rising-rate environment
  - Losses→suspension of remittances to Treasury, creation of deferred asset, not reduction of capital
  - Can arise from rising federal debt, higher growth, reversion to higher real rates, inflation scare

Effective lower bound "traps"

Several anomalies theoretically possible with interest rates near zero:

Liquidity trap: infinite interest-rate elasticity of money demand

Safety trap: safe-asset shortage at very low rates induces recession

- Demand for safe assets exceeds supply with (nominal and real) safe-asset yields near zero ($\rightarrow$rising spreads and safety channel)
- Real output declines, reducing demand for safe assets via wealth effect, to re-equilibrate safe-asset supply and demand

Secular stagnation: weak demand contributes to low real rate

- Monetary policy cannot attain low real rate at effective lower bound with low inflation target
- Convergence to equilibrium has been achieved through *both* decline in potential output and unsustainably easy financial conditions
- Weak demand$\rightarrow$feedback on potential output, lowering real rate

Neo-Fisherian trap: low real rates force expected inflation below target

- Fisher equation as identity: low nominal and real rate$\Rightarrow$low expected inflation

Stein critique of LSAPs

- LSAPs may increase leverage rather than stimulate real economic risk-taking and growth
- Investment decisions depend on path of future rates, not long-term rate
- $\Rightarrow$LSAPs must lower path of short-term rates to influence capital-spending decisions
- Lower term premium
  - Cannot stimulate additional real capital investment
  - Can only induce substitution of long- for short-term debt financing

Unconventional monetary policy and inflation

- The expected inflation that didn't happen 2008–09
- And the surprise inflation that did 2021–
- Inflation risk a key concern as unconventional policy initiated
  - From mid-2008: rising oil, commodity prices
  - ECB deposit rate increased July 2008
- Why no resurgence of inflation during QE?
- Look to behavior of inflation expectations, money supply
- 2008– experience: expected inflation low and falling
  - Survey expectations stable through 2008, then declining
  - Market-implied expected inflation initially volatile, declining from 2013
  - Sharp decline late 2008 due to flight to safety and liquidity, market shuns less-liquid TIPS
- Contrast to 2021–
  - Survey expectations rise sharply
  - Market-implied expected inflation higher but apparently contained
  - TIPS market stable

Inflation scenarios mooted during global financial crisis

- Inflation risk scenarios if recovery takes hold and output gap diminishes
  - Bank lending recovering, can increase massively, Fed control weak
    - Could be inhibited with sharp but disruptive increase in IORB
  - Surprise acceleration of inflation resulting from wage increases
    - $\rightarrow$Unanchoring of inflation expectations
  - Fed runs economy "hot" to increase participation, reduce long-term unemployment and part-time share
    - $\rightarrow$More gradual but possibly persistent unanchoring of inflation expectations
- Scenarios$\rightarrow$need to tighten more sharply than desirable
  - Potential trigger for renewed recession

Controlling reserves with a large balance sheet

- Once balance sheet grows, Fed endeavors to retain control over target rate and monetary base
  - Avoid more expansionary monetary stance than intended
- Initially **sterilization:** change composition of assets and liabilities
  - Fed sells T-bills, then bonds, offseting emergency loans on asset side of balance sheet
  - Replace monetary with nonmonetary central bank liabilities, reducing monetary base
- **Supplementary Financing Program** (SFP) 17Sep2008: Treasury issues T-bills, proceeds placed with Fed
  - SFP limited by fiscal constraints, e.g. debt ceiling
  - Requires cooperation with fiscal authorities($\rightarrow$fiscal and monetary policy)
- Interest on reserves lets central bank separate quantity of reserves from monetary policy objectives
  - Inhibit expansion of commercial bank lending
- Some central banks issue bonds, e.g. to offset foreign-exchange reserve accumulation
  - Not contemplated by Fed

Behavior of money supply and unconventional policy

- Quantitative easing leads to large increase in **monetary base**
  - Defined as subset of Fed liabilities: currency in circulation plus reserves
  - Early crisis increase almost entirely excess, not required, reserves
  - From commercial banks' standpoint, reflects modest deposit creation compared to reserve requirements
- But slower increase in money stock$\rightarrow$ drop in **money multiplier**
  - Money multiplier typically slow-moving, governed by reserve requirements
  - Stable money multiplier historically reflects near-zero excess reserves
  - Decline in multiplier in crisis$\Leftrightarrow$massive increase in excess reserves
  - Quantitative easing can be viewed as central bank increasing narrow money supply to offset decline in broad money supply

Money multiplier 2006–2024

Measured as ratio of M1 money stock (sa) to monetary base (nsa), monthly, Jan 2006–Apr 2025. Vertical shading represents NBER recession dates. *Source*: Board of Governors of the Federal Reserve System, H.6 release, Money Stock Measures, via FRED.

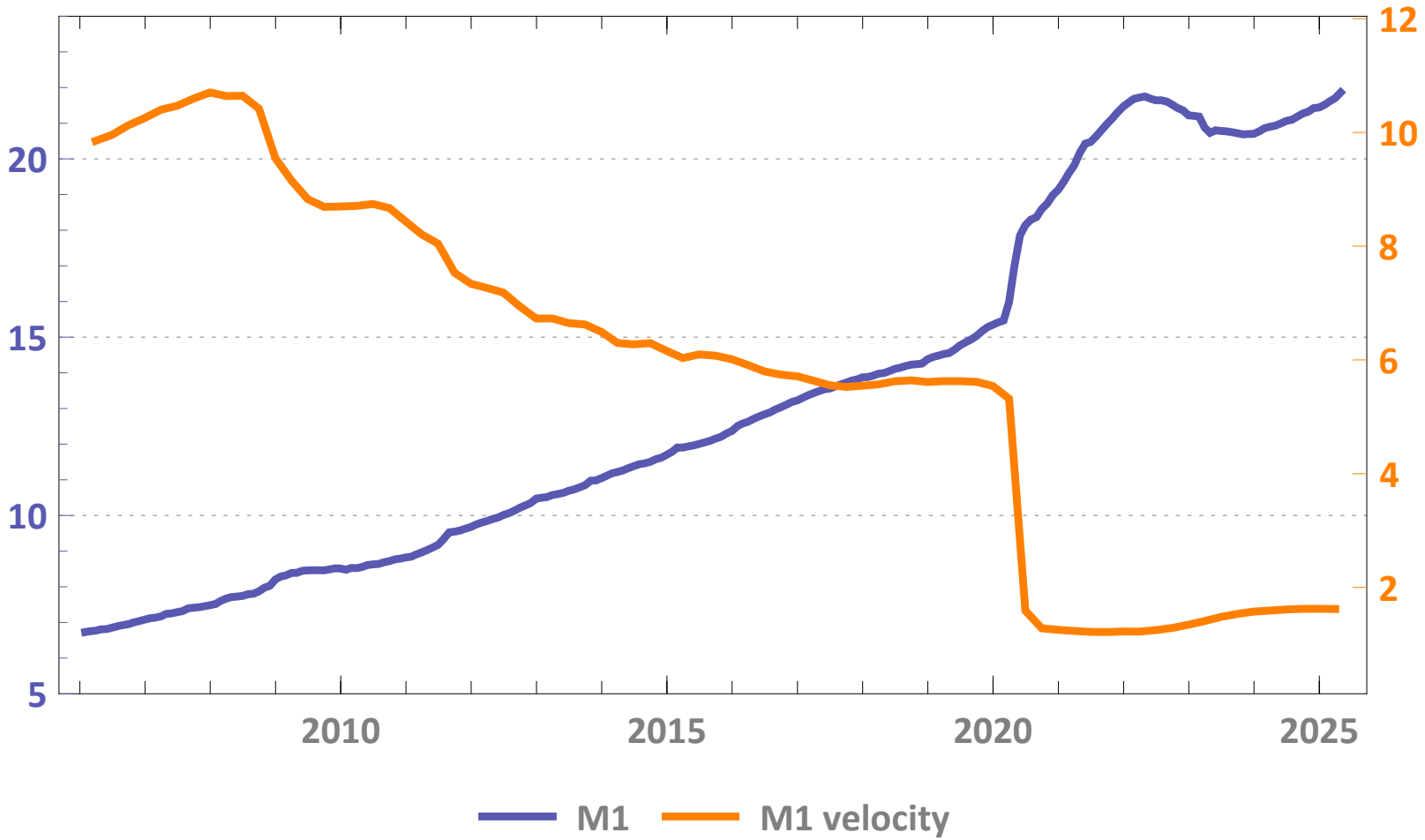
Bank lending and the money supply

- Also observed: modest decrease in **velocity of money:** ratio of money supply to income (GDP)
  - Lower velocity⇔fewer transactions effected by given money stock
  - Corresponds to modest increase in money balances held by market participants
  - Increase in liquidity preference a typical crisis phenomenon
- Bank lending *is* deposit creation for commercial banks *collectively*
  - Excess reserves/low money growth corresponds to weak bank lending
- Demand for interest-earning assets: weak demand by banks for commercial loans as assets
- Supply of interest-earning assets: IORB keeps money supply from rising by inducing banks to hold excess reserves in place of alternative liquid assets, loan expansion
- Low inflation⇔low bank lending⇔low money growth

Controlling inflation with a large balance sheet

- What tools available to central bank to keep money supply from rising without selling assets?
- Increase IORB to keep reserves locked up
  - Remittances to Treasury a concern: public-debt burden initially low, rising sharply with higher rates
  - At odds with lowering IORB below upper limit of target range to enhance money market liquidity
- Change composition of liabilities away from reserves→exit tools, e.g. ON RRP
- Limitations on use of reserve requirements, phased out in U.S. 2020
  - And reminiscent of bad 1937 experience
- Inflation expectations, well anchored over 3 decades, key in either case

Money stock and velocity 2006–2025



M1 money stock, $ trillion, monthly, Jan. 2006 to Apr. 2025, and velocity of M1 money stock, quarterly, Q1 2006 to Q1 2025, both seasonally adjusted.*Source*: Board of Governors of the Federal Reserve System H.6 release, Money Stock Measures, and the Federal Reserve Bank of St. Louis, via FRED.

Longer-term uncertainties for containing inflation

- New/old dilemma: financial stability vs. inflation goal
  - Attenuated by tightening effect on financial conditions of risk aversion and market volatility, substitute for Fed tightening
  - But what if stability concerns cause hesitation to raise rates ("Greenspan put")?
- Output growth challenges: war, investment subsidies, impulse to autarchy
  - Protectionism and "near-" or "friendshoring" reverse previous trend
  - Aggregate investment, private and public equity markets slowing
- Tariffs induce additional sources of uncertainty
  - Tariffs in principle lead to a one-time increase in price level
  - Extent and duration of price response uncertain
  - Should monetary policy "look through" tariff-induced price-level increase?

Exit from extraordinary accommodation

- Exit: remove accommodation and normalize rates
  - Raise target and short-term market rates away from zero
  - Reduce size of Fed balance sheet
- As recovery sets in, what is best *sequencing* of exit steps?
  - Back to open market operations? Requires vast reduction in reserves via bond sales to recreate reserve tightness
  - Would raise long-term rates and reverse salutary effects of LSAPs
- $\rightarrow$Do it the hard way: *rates first, then balance sheet*
  - Initiate rate hikes while maintaining large balance sheet
  - Recalls dilemmas of late 2008, but in reverse: support asset markets while controlling volume of reserves
- Exit underway since 2014
  - Balance sheet: "tapering," slowing of pace of purchases, from Jan. 2014
  - Fed funds target rate increases beginning Dec. 2015
  - Reduction of reinvestment of principal payments from Oct. 2017

Exit strategy: key challenges

- Money market conditions: awash in liquidity
  - Normal monetary operations rely—at least in theory—on liquidity effect underpinning banks' reserve demand function
  - Post-crisis, reserves abundant, well above banks' liquidity needs
  - Pre-crisis approach to overnight rate control not possible
- Tapering a communication challenge
  - Tapering slowed pace of *adding* accommodation, was not *removal* of accommodation
- Asymmetrical risks of error near zero bound
  - Lift-off too slow: subsequent tightening more aggressive (but Fed knows how to combat inflation)
  - Lift-off too fast: high cost to real economy, need to ease again, attendant political and communication nightmare
- Market volatility: potential decline in stock market, "risk-off"
- International impact of rising rates and strong USD
- Mark-to-market or realized losses on Fed balance sheet as rates rise
- Political challenges of raising IOER

Central bank liabilities during exit

- Large volume of liabilities corresponding to asset purchases
  - Reduce volume via asset sales or run-off
  - Sterilize, i.e. exchange for non-monetary liabilities
  - Keep money multiplier low via IOR
- Banks have large amounts of excess reserves, corresponding to large Fed balance sheet
  - Banks have ample liquidity, no need to borrow in funds market
  - $\rightarrow$Diminished activity in fed funds market
  - $\rightarrow$Harder to control funds rate through normal operations
- Some central banks issue bonds, e.g. to offset foreign-exchange reserve accumulation
  - But not contemplated by Fed

Normalization: new tools to control target rate

Interest on reserve balances (IORB) introduced in 2008

- Plays different role during exit
- Help keep rates comfortably within target range
- Removal of minimum reserve rules for banks 26Mar2020

Term Deposit Facility (TDF), announced 30Ap2010, only test exercises to date

- Drain reserves, 7 or 28 days
- Can be used to satisfy regulatory liquidity rules, but not for clearing

Overnight Reverse Repurchase Agreement Facility (ON RRPs): test exercises since Sep. 2013, used at scale since 2015

- Offered to wide audience, including MMMFs, GSEs
- Fixed amount or full allotment at fixed award rate (5–10bps)

Contradictory developments in money markets

- Short-term wholesale funding markets grew dramatically up to global financial crisis
- Since crisis:
  - Trading and issuance volumes lower
  - Markets in central bank reserve balances virtually disappear
- Money markets awash in liquidity
  - Rates near zero 2008–16 and 2020–22
- Yet sporadic episodes of spikes and extreme volatility of short-term rates
- Declining integration: different money market rates track each other less closely
  - E.g. lower correlation of daily changes
  - Largely, but not completely, integrated→incomplete arbitrage
  - Integration crucial for transmission of policy rates to market rates
- Major regulatory changes post-crisis
- New monetary policy tools introduced by Federal Reserve, other central banks

Shifts in money market participants

- Bank and dealer activity reduced
  - Short-term borrowing less attractive to banks
  - Declining role of broker-dealers in low-risk "arbitrage"
- Leveraged funds role grows, especially near-arbitrage trading
  - But leverage provided in large part by prime brokerage subsidiaries of BHCs
- Greater MMMF role in short-term intermediation, e.g. eurodollars, ON RRP
  - And shift to government liabilities

The dormant fed funds market

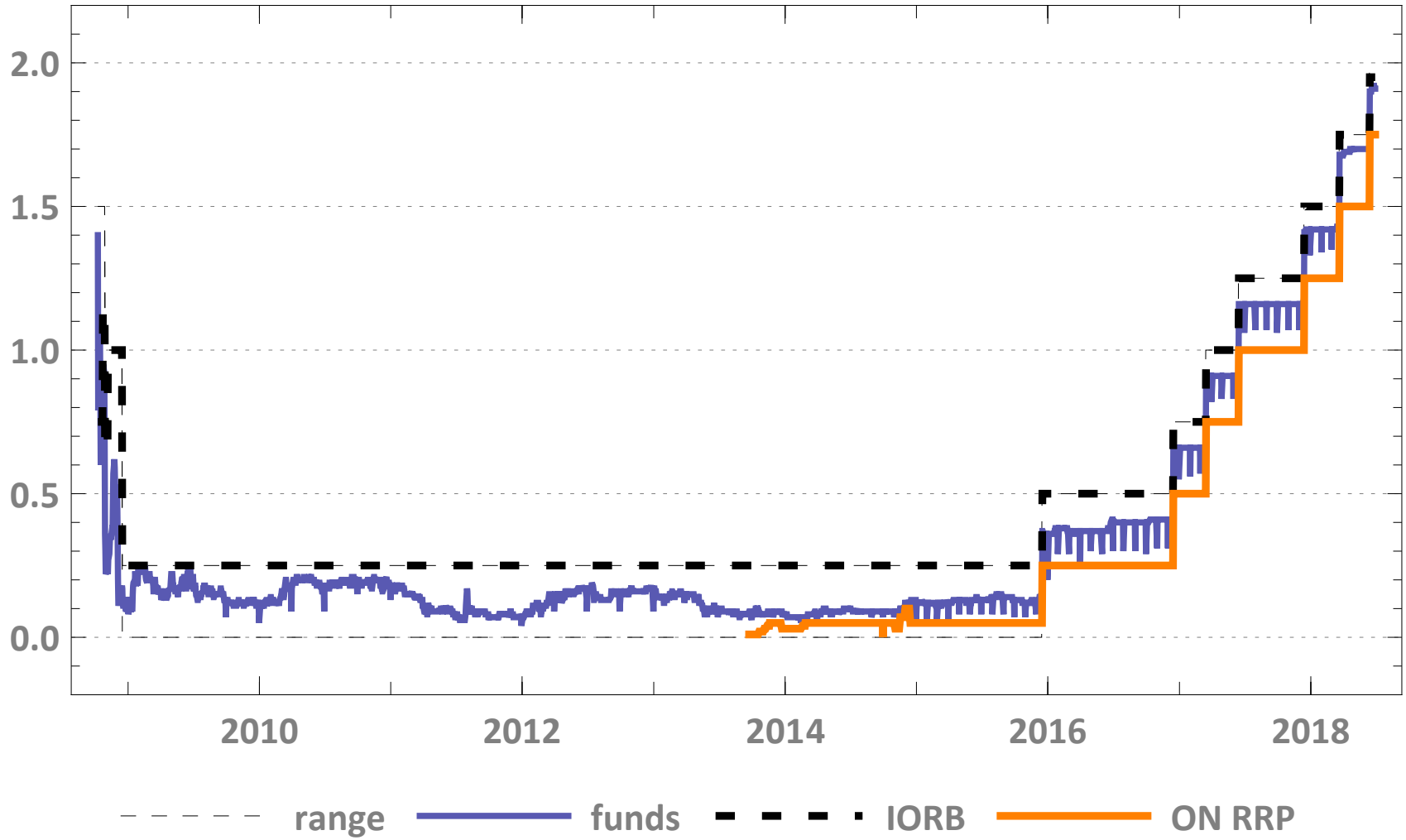
- Trading volume virtually disappears
- Dominated by FBOs borrowing from GSEs to earn IORB
- Market soggy, hence target rate expressed as 25 bps range
- Normal monetary operations ineffective, since based on structural deficiency of reserves
- Funds rate stabilized near center of range by mid-2009

Target minus effective funds rate

	mean	std. dev.
03Jan2000–10Aug2007	0.7	9.9
13Aug2007–31Mar2009	-11.6	27.7
01Apr2009–05Jan2016	-12.3	4.0

Mean and standard deviation of the effective fed funds rate minus the target fed funds rate (until 16Dec2008) or the upper limit of target range, daily, in basis points. *Data source*: Bloomberg LP.

U.S. money market rates 2008–18



All rates in basis points, daily, 09Oct2008 to 29Jun2018. *Source*: Bloomberg LP.

Fed funds market participants

U.S. commercial banks :

- Eligible to earn IORB from Fed
- But face regulatory costs
  - Liquidity regulation, e.g. **Liquidity Coverage Ratio** (LCR)
  - U.S. capital charges, e.g. **Supplementary Leverage Ratio** (SLR)
  - FDIC deposit insurance assessment base: assets minus capital rather than deposits

Government-sponsored enterprises (GSEs)

- Esp. Federal Home Loan Banks (FHLBs)
- As government entities, eligible to hold deposits at Fed
- But *not* eligible to earn IORB
- Bulk of lending in shrunken funds market

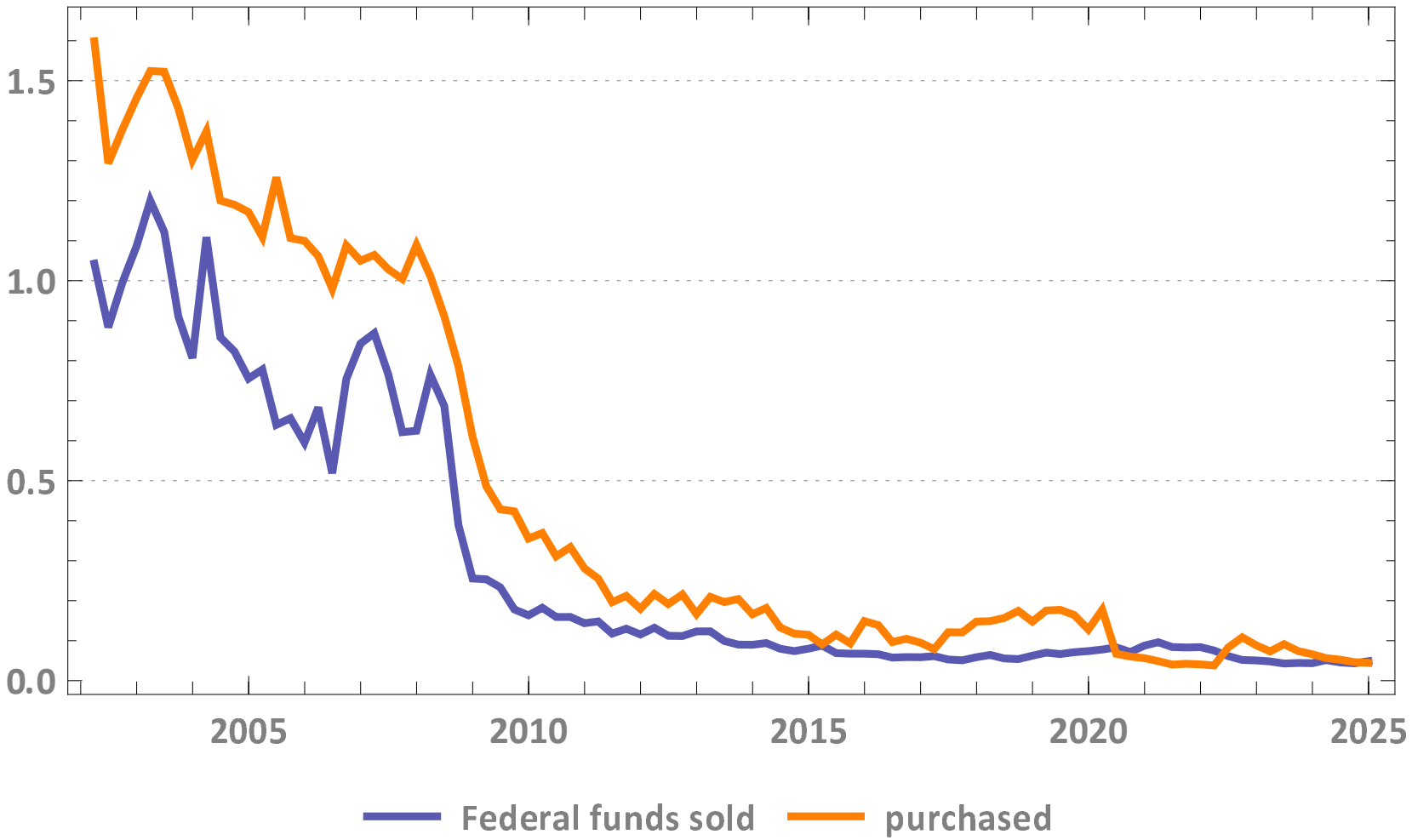
U.S. offices and branches of foreign banks (FBOs)

- Eligible to earn IORB from Fed
- Fed funds a source of U.S. dollar funding
- Not subject to SLR, FDIC deposit insurance assessment
- Large borrowers of Fed balances

The fed funds-IORB arbitrage

- IORB a leaky floor due to incomplete arbitrage in money markets
  - But note it is to be a ceiling and a magnet during normalization
- Potential arbitrage in money markets
  - If funds rate below IORB, borrow funds and lend to Fed until funds rate rises to eliminate spread
- FHLBs receive large and lumpy interest payments from mortgage borrowers
  - $\rightarrow$Willing suppliers of o/n funds below IORB rate
- FBOs borrow reserves, earn IORB-funds spread
  - Banks could, but don't, borrow from FHLBs
  - FBOs carry out much of existing IOER arbitrage
- Esp. large banks: large holdings of central bank reserve balances, but little trading

Fed funds sold and purchased by banks 2002–2024



As a percentage of total assets of domestic offices of US commercial banks and BHCs. Quarterly, Q1 2002 to Q4 2023. *Source*: Federal Reserve Bank of New York, Quarterly Trends for Consolidated US Banking Organizations.

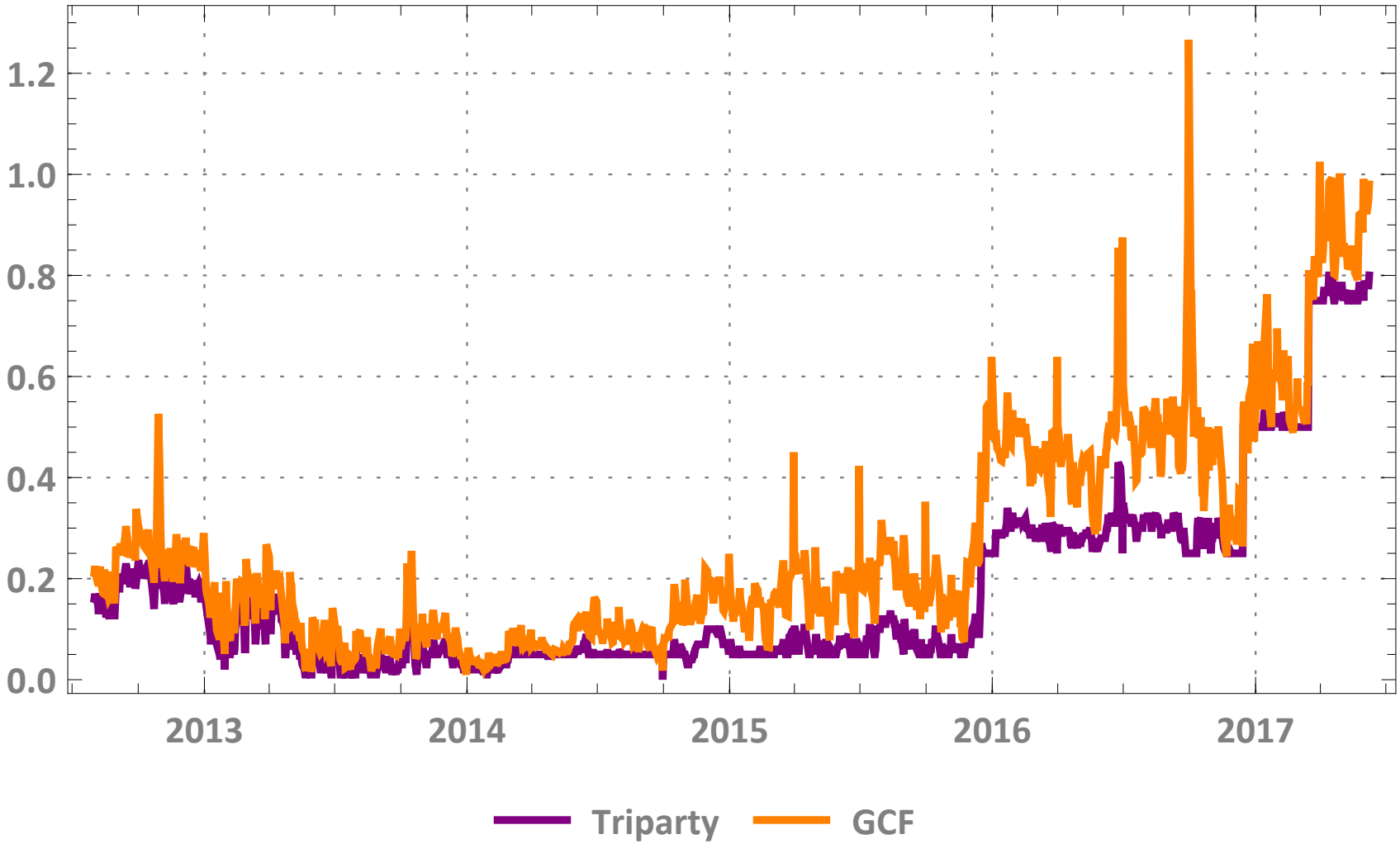
Repo markets

- Higher capital and new liquidity standards decrease profitability of repo dealing
  - Repo dealing has low profit margin, low risk
  - Leverage ratio—if binding—disincentivizes use of **"balance-sheet capacity"**
  - Liquidity standards: Liquidity Coverage Ratio (LCR)→less attractive to supply high-quality liquid assets (HQLA) as collateral
    - Treasury repo has zero run-off assumption
- Impact on repo markets
  - During the crisis, desire for safety dominant: need for collateral, safe assets→repo rates falling well below funds rate
  - Although secured, dealer-intermediated GC repo higher than unsecured fed funds rate
  - Increase in incidence of **fails**, failure to deliver collateral at conclusion of repo transaction
- Implications for→exit from extraordinary accommodation: changes in market functioning, transmission mechanism

Incomplete arbitrage in money markets

- Fed funds below comparable money market rates
  - Trades lower than repo, a secured rate
  - IOER has not acted as floor for funds rate, becomes ceiling during normalization
- Repo "bid-ask spread" wide and volatile
- GCF repo: dealer-to-dealer, dealers to hedge funds
  - Matched books
- Triparty repo: dealers source cash and securities
  - Provided by MMMFs, institutional investors

Triparty and GCF repo rates 2012–2017



Triparty: BNY Mellon Treasury Tri-Party Repo Index; GCF: DTCC GCF Repo Index for Treasury, percent. *Data source*: Bloomberg LP, Bank of New York Mellon.

Potential for "accidents" during exit

- How tightly can Fed control rates during exit?
  - Money market rates consistently below IOER, IOER doesn't act as floor
- ON RRPs put high-quality collateral into market, firming rates, their borrowing cost
- Availability of ON RRPs may make system more run-prone
  - ON RRPs as safe-haven asset
- Market volatility (e.g., taper tantrums) may help or hinder exit
  - Volatility works in tandem with exit by tightening financial conditions
  - Low volatility may ordain more aggressive tightening ("Yellen collar," risk-on increases likelihood of further tightening)
  - "Yellen collar:" lean toward further tightening in risk-on environment, pause tightening in risk-off

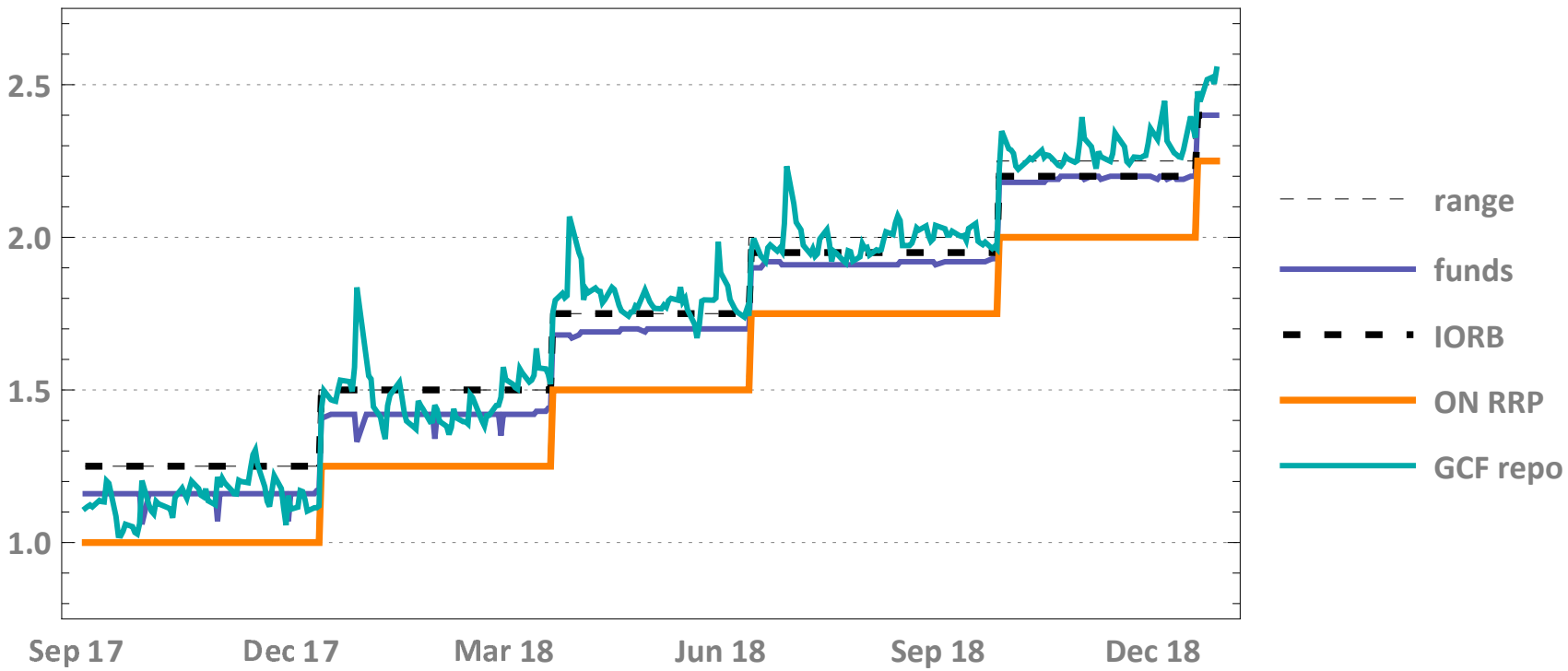
From soggy to tight

- October 2017: slow runoff of assets initiated
- Technical adjustments aka tweaks: IORB rate lower than upper limit
- Signs of tight money markets in 2018
- Funds rate moving close to upper limit
  - Undesirable for Fed, breaches not just possible but likely
- Repo trading above, not below funds
- 20Mar2019 announcement: balance sheet runoff to slow from May, then end September 2019
  - 31Jul2019: end to runoff moved up two months

Conditional liquidity shortage

- Liquidity paradox
- Ample reserves, but banks commit their liquidity
  - **Example**: lines of credit
- Market making is balance-sheet intensive
- Important mechanism in the 2023 banking turmoil

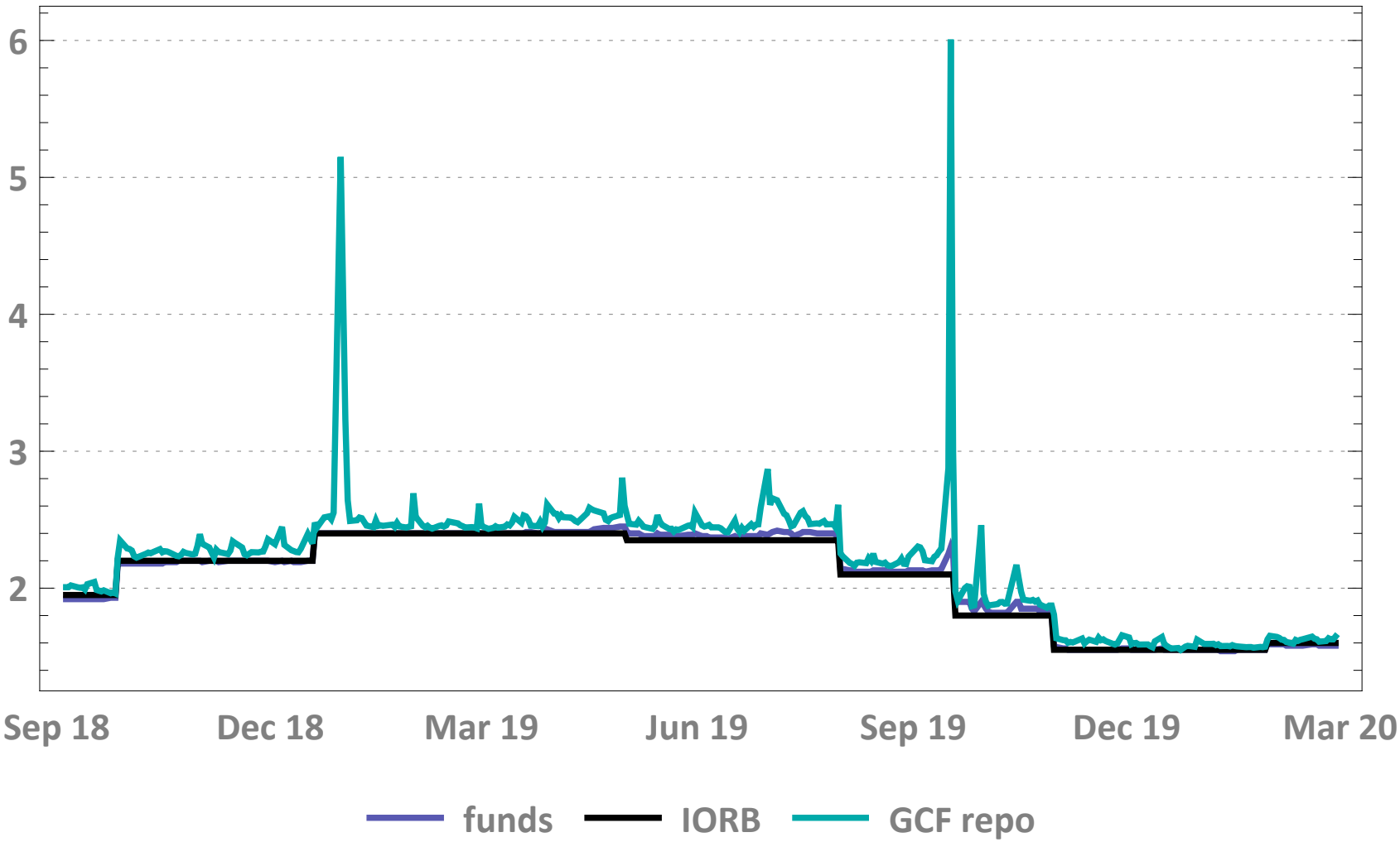
Money markets in 2018



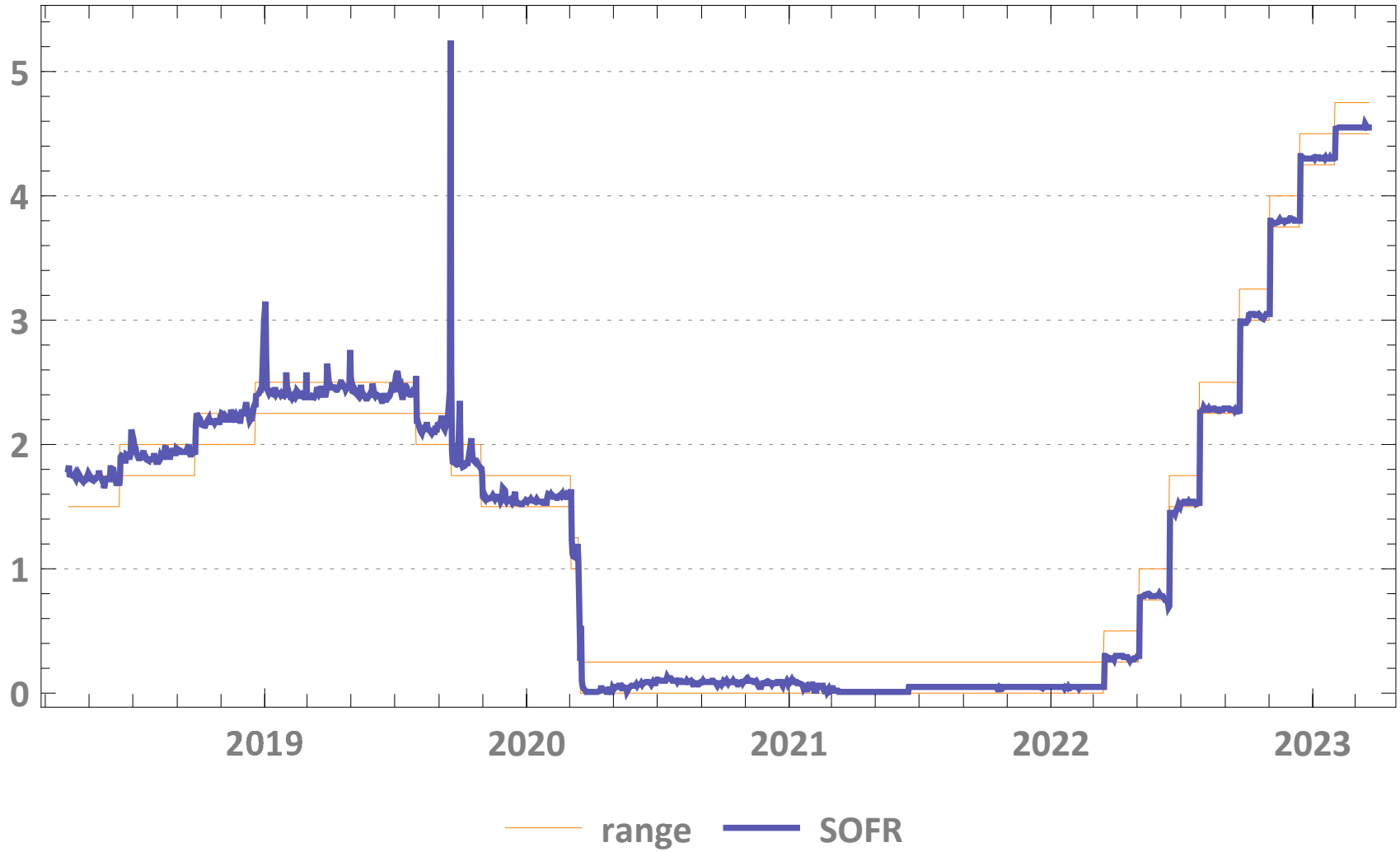
The repo market turmoil of September 2019

- Additional factors impacting Treasury market
  - Quarterly corporate tax payment deadline: TGA↑, reserves↓
  - Increase in Treasury issuance
- Repo trades at 10 percent, closes at 6 percent
- Federal Reserve response
  - Large-scale open market operations
  - Further reduction in IORB
  - Outright purchases of Treasury bills

Repo market shocks



Fed target range and overnight rates 2018–2023

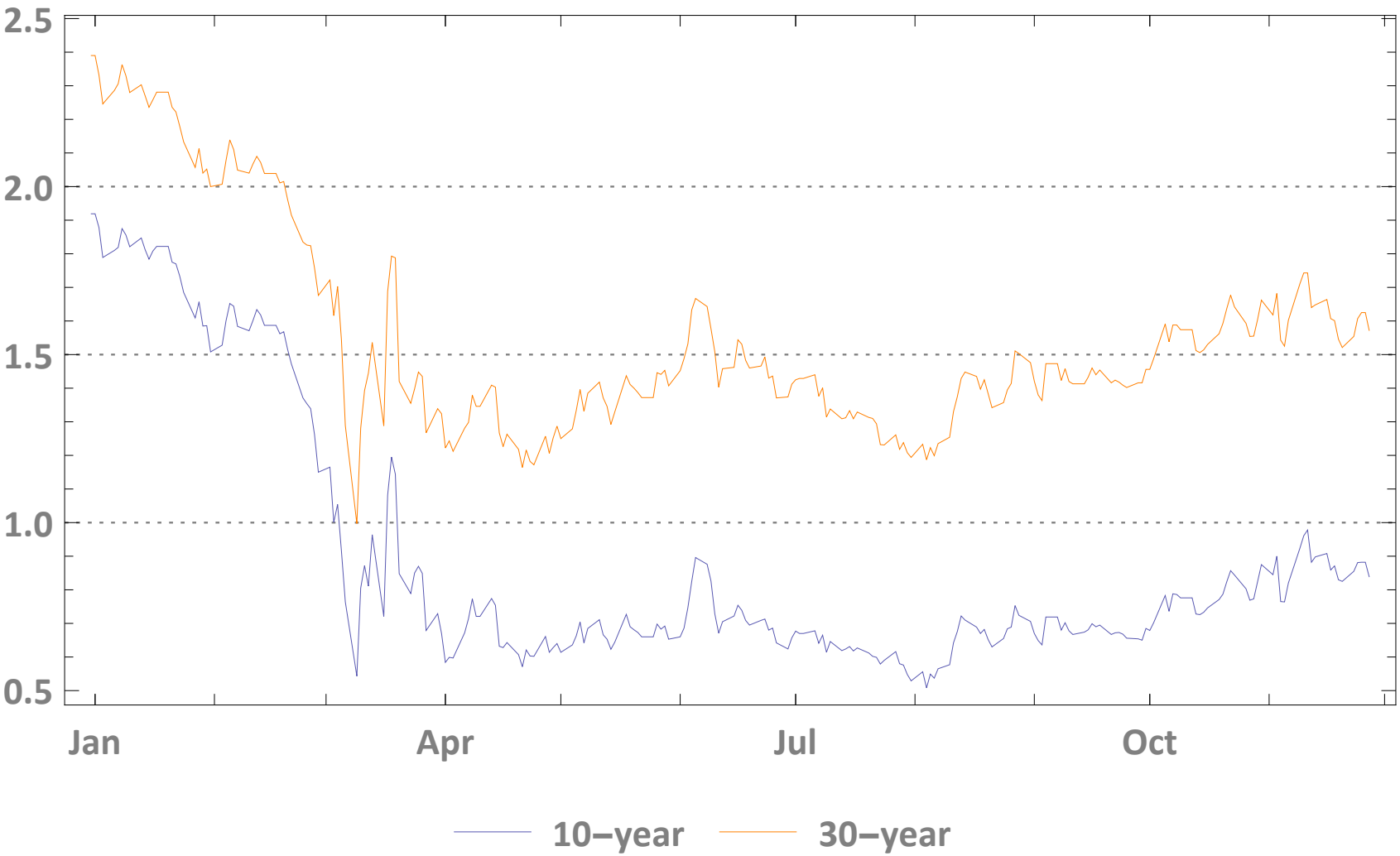


Federal funds target range and Secured Overnight Financing Rate (SOFR) daily, 02Apr2018 to 20Mar2023. *Source*: Bloomberg LLP.

Impact of the COVID pandemic on financial markets

- Evaporation of economic activity
- Increased credit risk
- Impaired funding liquidity in U.S. Treasury market
  - Reluctance of hedge funds to maintain leveraged positions
  - Reluctance of banks and dealers to extend credit or absorb positions
- But also flight to safe assets
  - Extreme volatility in bond markets
- Illiquidity in offshore U.S. dollar funding markets
  - Increased foreign demand for U.S. dollars: foreign banks' dollar funding liquidity
  - Illiquidity of foreign banks' dollar funding

Treasury yields 2020



Source: Bloomberg Financial LP.

Federal Reserve monetary easing during COVID

- Fed funds target rate reductions from 1.5-1.75 to 0-0.25 percent
- Large-scale open market operations
- Further reversal of balance sheet reduction
  - Purchases of Treasury notes, bonds, agency MBS resumed
  - And increase in volume of Treasury and MBS purchases
- Aggressive forward guidance
  - As late as 16Dec2020: tapering to resume only upon "substantial further progress" toward goals

Federal Reserve COVID emergency lending

- Emergency lending to stabilize money markets
  - Reopening of MMLF, CPFF, PDCF
- Resumption of QE acts to stabilize Treasury markets
- Stabilization of offshore dollar funding markets
  - Expansion of dollar liquidity swap lines with other central banks
  - Introduction of **FIMA Repo Facility** for foreign and international monetary authorities
- Support of corporate bond markets
  - Corporate bond purchases: **Primary** and **Secondary Market Corporate Credit Facilities** (PMCCF and SMCCF)
  - Revival of TALF
- Support of bank lending
  - Particularly to large and small nonfinancial firms
  - Suspension/postponement of regulatory changes, e.g. inclusion of fed funds, Treasurys in SLR, introduction of CECL
- Support of municipal bond issuance: **Municipal Liquidity Facility**
  - Via direct purchases from issuers

Government response to COVID

- Large transfers to households and businesses, i.a.
  - Direct stimulus payments
  - Increased unemployment benefits
  - Transfers to state and local governments, hospitals
- **Paycheck Protection Program** (PPP): forgivable loans to small businesses
  - Fed refinancing via **Paycheck Protection Program Liquidity Facility** (PPPLF) loans
- Direct payments initially flow to demandable deposit accounts
  - Large immediate increase in the money supply and decline in the velocity of money
  - Increase in bank assets, esp. securities holdings

The troubled U.S. banking system

- High rates usually good for banks
  - $\rightarrow$Higher **net interest margin** (NIM): interest income minus cost
  - But getting there a nightmare
- A flood of deposits, followed by steady outflows
  - Banks less able to retain deposits in rising rate environment
  - Competition among banks, from money funds
  - NIM has been rising, but more recently deposit costs as well
  - Uninsured share currently 43 percent
  - Roku: \$487 million at SVB, $>$25 percent of total cash
- Higher asset risk and unrealized losses
  - Loan-to-deposit ratios—measure of liquidity risk—rising
  - Loan loss reserves rising
  - U.S. banks' unrealized losses on loans and securities estimated at \$1.75 trillion

The March 2023 bank failures

- The Silicon Valley Bank (SVB) episode is a typical example of effects of low interest rates
- Two weeks, 4 U.S. banks gone, 2nd- and 3rd-largest U.S. failures
  - Deposit drain, forced securities sales, stock price plunge
  - U.S. banks: concentrated assets and funding
- Silvergate Capital Corp (SI): crypto industry
  - March 8: voluntary liquidation
- Silicon Valley Bank (SVB): venture capital
  - Assets include high share of interest-rate sensitive securities
  - Failed capital raise
- Signature Bank (SBNY): commercial real estate
- March 10: runs on SVB and SBNY
  - SVB: $42 billion withdrawn within hours
  - First Republic Bank under pressure
  - Example of reduced "stickiness" of deposits due to technological developmenrs
- Europe: Credit Suisse (CS) acquired by UBS March 18–19
  - Deutsche under pressure
- Market functioning at times impaired, esp. Treasurys

The policy response

- SVB and SBNY March 10–12→FDIC receivership
  - All depositors whole: "systemic risk" exception
- New Federal Reserve 13-3 facility: **Bank Term Funding Program** (BTFP) lends long-term against Treasury collateral valued at par
- Fed **discount window** lending: easier terms, large increase
- Swiss authorities facilitate CS, AT1 bond "bail-in"
- Federal Reserve **central bank liquidity swaps** revived

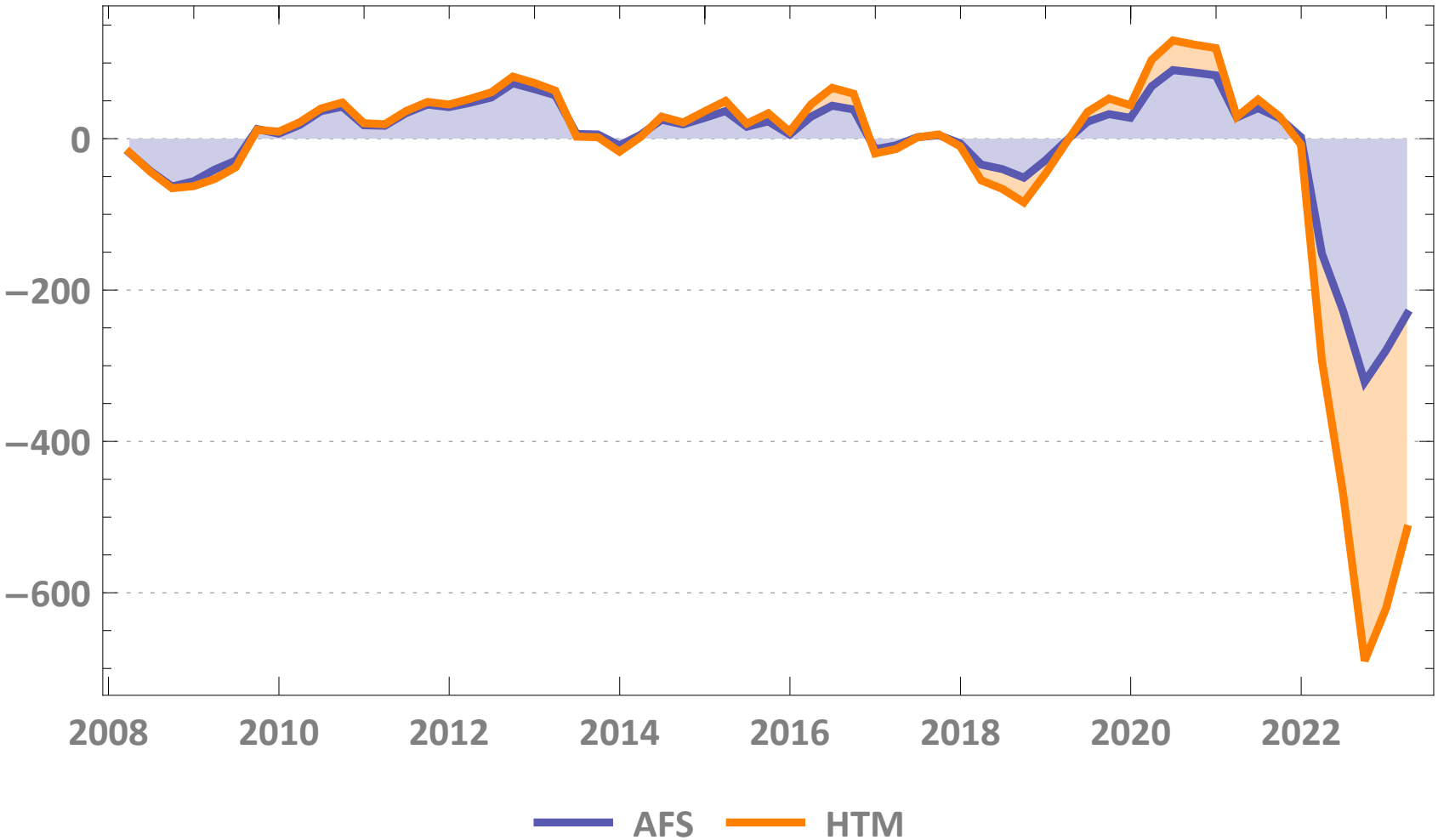
2022 wasn't so much fun, either

- Rising interest rates, increased risk aversion, declines in asset values
  - Inflation surprise and simultaneous decline stock and bond markets
  - Four consecutive +75 bps hikes
- Crypto: insolvency and illiquidity of exchanges, stablecoin issuers
- October 2022: U.K. pension fund losses from liability-driven investment (LDI) strategies
  - Strategies to hedge interest rate risk, juice returns
- Early 2023: highly leveraged Adani Group
  - Difficulty rolling over debt in higher-rate environment

Skeletons still in the closet

- Immediate crisis contained
- SVB et al. typical or atypical? SVB business model or overall conditions?
  - More reliant than most banks on uninsured deposits from a narrow group of lenders (funding)
  - High share of interest-rate sensitive securities, concentrated loans in one sector (assets)
- But flood of deposits, interest-rate risk, past lending conditions affect all
- Longer-term problem from strengthening of implicit guarantees
  - Deposit insurance limits increased or effectively unlimited?
  - Increasing moral hazard→**gambling for resurrection**
- Concentration of banking sector increases as
  - Deposits flow to large banks
  - More complex regulation raises compliance cost
- Dollar strengthening could trigger foreign debt crises in EM

Banks' unrealized gains 2008–2023



Unrealized gains on available-for-sale (AFS) and held-to-maturity (HTM) securities (negative numbers indicate losses), $ billions, quarterly, Mar. 2008 to Dec. 2022.
Source: FDIC Quarterly Banking Profile.

Evolution of exit strategy

- Initially set out in testimony Feb. 10, 2010, minutes June 2011 ("Exit Strategy Principles")
  1. Reduce pace of asset purchases (tapering)
  2. "cease reinvesting some or all payments of principal"
  3. "modify...forward guidance...and...initiate temporary reserve-draining operations"
  4. Gradually sell MBS
- Runoff without MBS sales mooted: June 2013 press conference
- Asset purchases to end well before rate hikes Mar. 2014
- Formal announcement of revised approach to sequencing 16Sep2014 ("Policy Normalization Principles and Plans")
  1. Tapering near done, so no discussion of pace of purchases
  2. Cease reinvestment at indeterminate future date, but no sales
  3. Desire to shift Fed assets to Treasuries as MBS pay down
  4. Funds rate remains intermediate target; range, not a point
  5. IOER as key tool to control funds rate, limited use of ON RRP
- Addendum of 13Jun2017: more detail on runoff plan
  - Gradual start, then acceleration up to certain caps

Floor system for funds rate during exit

- IOER *floor*, ON RRP "sub-floor" on effective fed funds rate
  - Technically still a corridor system, as discount rate still set, though barely used
  - IOER as primary tool to set rates near target
  - Wide ON RRP-IOER spread→active funds trading
- Fed funds rate remains target, supported by system of administered rates until normalization
- Keep effective funds rate close to 25 bps upper limit of target range
- Actual fed funds rate should get closer to IOER as reserves drained
  - Draining can however be temporary e.g. ON RRP, TDF
  - Switch liabilities, reducing reserves, but not balance sheet size

Hints of a new operating framework

- No reference in exit strategy to permanent changes in framework
- Apart from laconic references to
  - Holding " primarily Treasury securities, thereby minimizing the effect...on the allocation of credit."
  - "[R]educing...reserve balances...to a level appreciably below that seen in recent years but larger than before the financial crisis."
- But indications in Federal Reserve public statements that some elements of "exit strategy" may be part of new framework
  - E.g. ON RRPs, IOR
- Discussion of potential alternatives to fed funds effective rate as target
  - But likely with attention paid to a broader set of money market rates than pre-crisis
- Try to get from "abundant " to merely "ample" reserves regime
- After reduction of portfolio complete, maintain **ample reserves regime** larger balance sheet than pre-crisis to prevail for the
  - Return to LSAPs if ZIRP required in future

Impact of repo market (non)functioning

- Repo turmoil of 2019 exposed fragility of existing operations framework
- QT continues—gradually reduce Federal Reserve securities holdings—until end-2025
  - Announcements 26Jan2022 (`https://www.federalreserve.gov/newsevents/pressreleases/monetary20220126c.htm`) and 04May2022 (`https://www.federalreserve.gov/newsevents/pressreleases/monetary20220504b.htm`)
  - Reduction capped at specific amounts per month for Treasury and agency securities

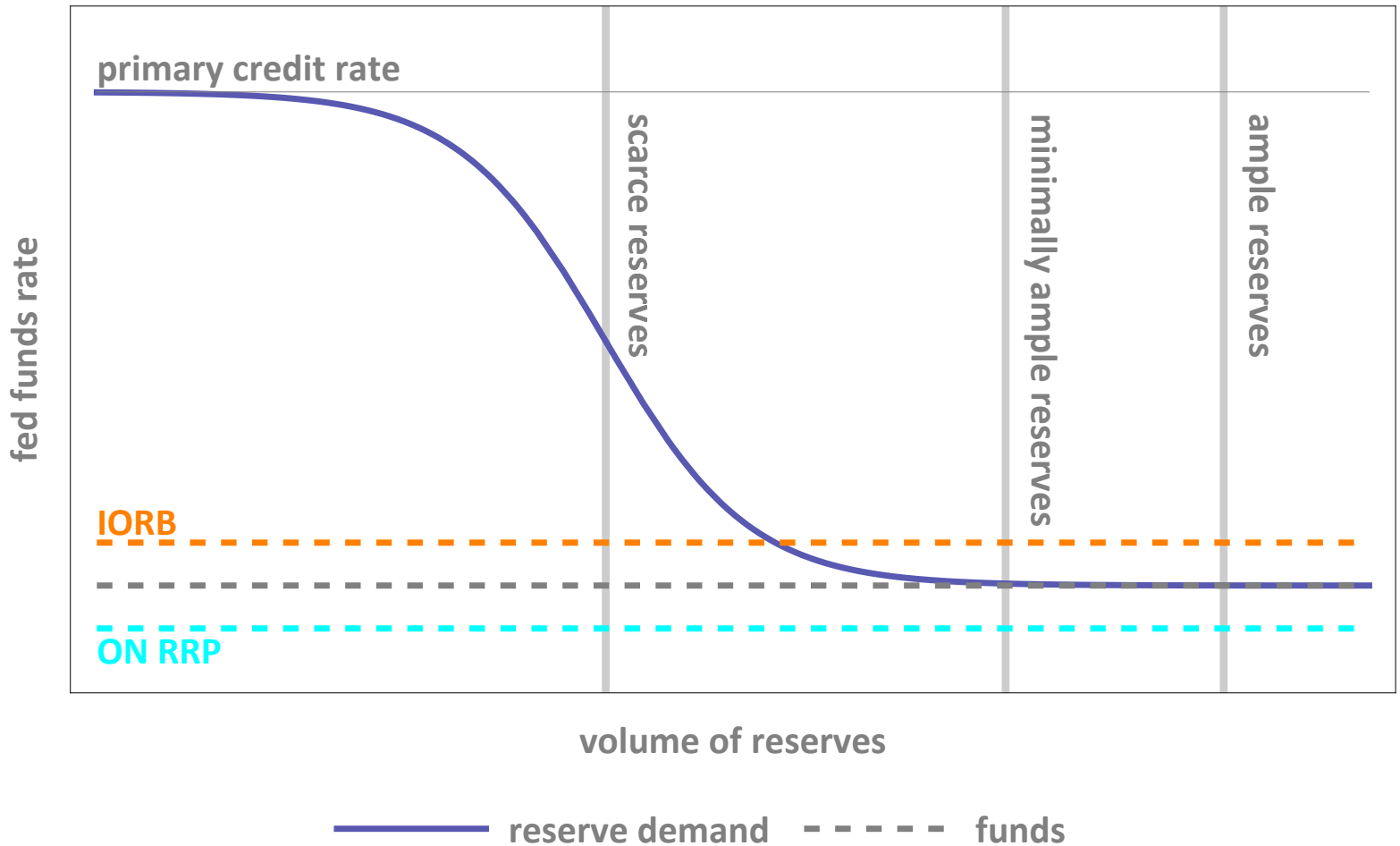
Standing Repo Facility

- **Standing Repo Facility** (SRF) announced 28Jul2021
  - But first used at scale late 2025
- Mechanism for infusing reserves into financial system
  - Open to primary dealers and domestic banks
  - Cash lending rate set at upper limit of target range
- Together with ON RRP facility, may establish authentic corridor system
  - If used regularly at scale
- Initially limited to \$500 bill. per day

Minimally ample supply of reserves

- Key challenge: estimate **minimally ample supply of reserves**
  - Smallest volume of reserves at which demand elasticity near zero
- If reserve supply too small—QT has continued too long—possibility reserve scarcity causes disruptions to money market
- If reserve supply too large—QT has ended too soon—funds rate chronically low relative to target range

Monetary operations with ample reserves



Purple plot shows the net demand of all depository institutions for reserves. At the prevailing funds rate and at the minimally ample volume of reserve balances. Diminution of reserves would place upward pressure on the funds rate, while an increase in reserves would result in no downward pressure.

Reserve Management Purchases

- Ongoing problem of market repo rates spiking higher than upper limit of target range
  - Intensifies in 2025
  - Ceiling tool SRF proves ineffective
  - Heavy SRF usage, but limited demand possibly attributable to stigma
- Limit on SRF daily total lending removed 10Dec2025
  - $\rightarrow$SRF becomes full allotment facility
- Fed response: termination of QT
- Introduction of market functioning or **Reserve Management Purchases** (RMPs)
  - Distinguished from QE: motivated by uncertain "ample" reserve volume
  - T-bills only (but possibly notes with maturities up to 3 years
  - Avoids imposing losses on Fed if and when reversed
  - Implementation Note 10Dec2025 (`https://www.federalreserve.gov/newsevents/pressreleases/monetary20251210a1.htm`)

The crisis monetary policy framework

- Expressed in 2012 *Statement on Longer-Run Goals and Monetary Policy Strategy*
- Background:
  - Policy at effective lower bound: real rates, expected inflation
  - Below 2 percent long-term inflation goal since GFC
- Augments (or supplants?) "shadow" Taylor-rule/reaction function
  - Recognizes importance of inflation expectations
- Specifies numerical inflation goal 2 percent
  - Not set at zero: take account of price stickiness, avoid ELB
  - No numerical employment goal
  - Not set at zero: take account of price stickiness, avoid ELB
  - No numerical employment goal
- Prelude to FAIT: unlikely but contemplated changes if very weak recovery
- Slightly less unlikely but possible: higher Fed short-term inflation goal
  - Higher Fed short- or even long-term inflation goal
  - Bank of England tolerating transitory foreign-exchange induced inflation $>$ 2 percent post-Brexit (04Aug2016)

Flexible average inflation targeting

- 26Jan2016 change to *Statement*: symmetry, respond if inflation "persistently above or below" 2 percent
- Dilemma if realized inflation persistently below 2 percent target
  - ELB limits effort to reach target from below
  - Response to above-target inflation
  - Expected inflation falls, raising real rate and reinforcing drag on output
- 27Aug2020 introduces **Flexible average inflation targeting** (FAIT) introduced from 2020
- Asymmetric inflation response
  - At ELB: form of **temporary price level targeting** (TPLT), "make-up" strategy
  - Refrain from tapering or raising rates in response to employment, near potential output
  - Similar to temporary nominal GDP targeting
  - Above ELB: inflation targeting