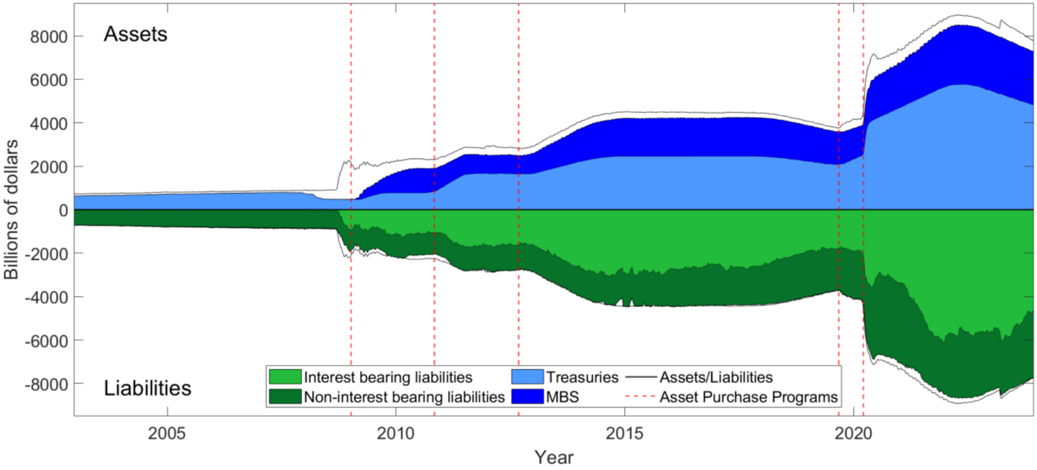
Central bank balance sheet size, net interest income, and policy rate amplification

Joseph Kachovec

Reserve Bank of Australia

January 3, 2026

Federal Reserve balance sheet (scarce vs abundant reserves)



Detailed Liabilities

Monetary policy implementation: scarce vs. abundant reserves

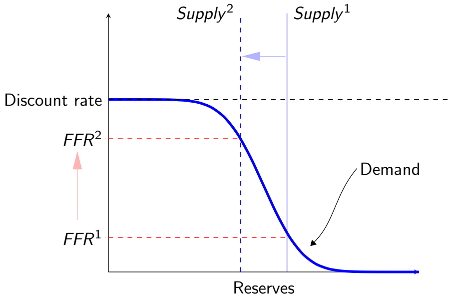


Figure: Fed funds targeting

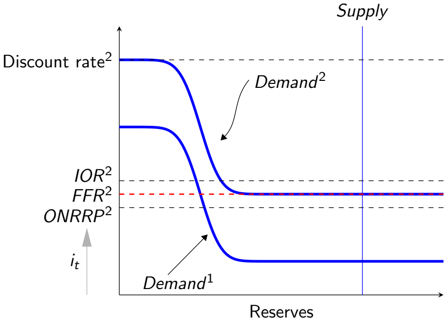


Figure: Administered rates

Correlation between policy rates and central bank income

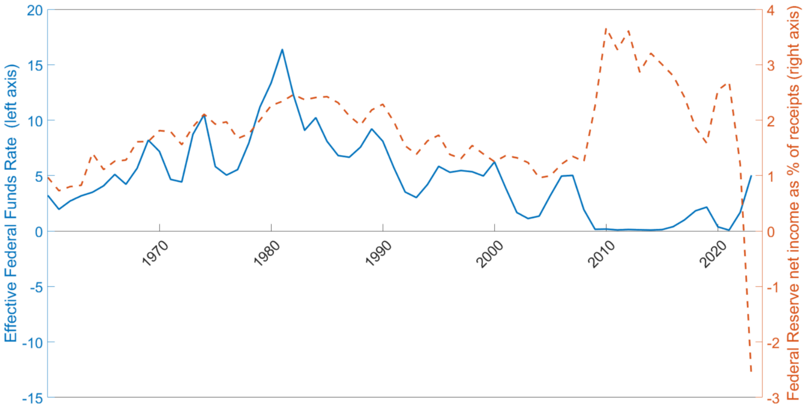


Figure: Federal Reserve net income and federal funds rate

Technical Description Nominal income

Summary of paper

- Identical interest rate moves have larger real effects under abundant reserves
  - not dependent on the type of aggregate shock
- Interest rate tightening with abundant reserves:
  1. increasing interest rates
  2. increases interest expense on central bank liabilities
  3. decreases central bank net income
  4. tightens the aggregate government budget constraint
- Contribution:
  - fixed size for the central bank balance sheet
  - conditional statements on the real impacts of interest rate policy (Assumption)
  - mechanisms of interest rate policy in the NK model are amplified under abundant reserves

Model setting

- NK model with 5 types of agents
  1. representative household (Household problem)
  2. continuum of firms producing differentiated goods (Firm problem)
  3. central bank (Fiscal authority problem)
     - Taylor interest rate rule
     - balance sheet w/ net income
  4. **passive** fiscal authority (Fiscal authority problem)
     - consumes a fraction of output
     - taxation w/ **output costs**
     - issuance of fixed or floating rate bonds
  5. representative financial intermediary (FI problem)
     - portfolio choice problem w/ three types of one-period assets
     - deposit withdraw uncertainty $\rightarrow$ interest rate spreads
- Exogenous shocks
  - aggregate supply, preference shock, government spending shock

Counterfactual design

- Question: What are the real impacts of interest rate policy in response to aggregate shocks?
- Experiment:
  1. keep model conditions constant (Baseline calibration)
  2. change the size of the central bank balance sheet (λ)
  3. hit different λ-economies with same shocks ($\varepsilon_t^{\xi}, \varepsilon_t^{A}, \varepsilon_t^{F}$)
  4. measure aggregate fluctuations in prices and output in each λ-economy compared to a pre-QE counterfactual of $\Lambda = .06$, $\lambda = 0$? (Measurement Description)

$$\underbrace{B_t^{CB} + L_t^{CB}}_{Assets} = \underbrace{.06 P_t Y_{ss} + \lambda P_t Y_{ss}}_{Assets} = \underbrace{RE_t}_{Liabilities}$$

Model mechanism IRFs (1% Preference Shock)

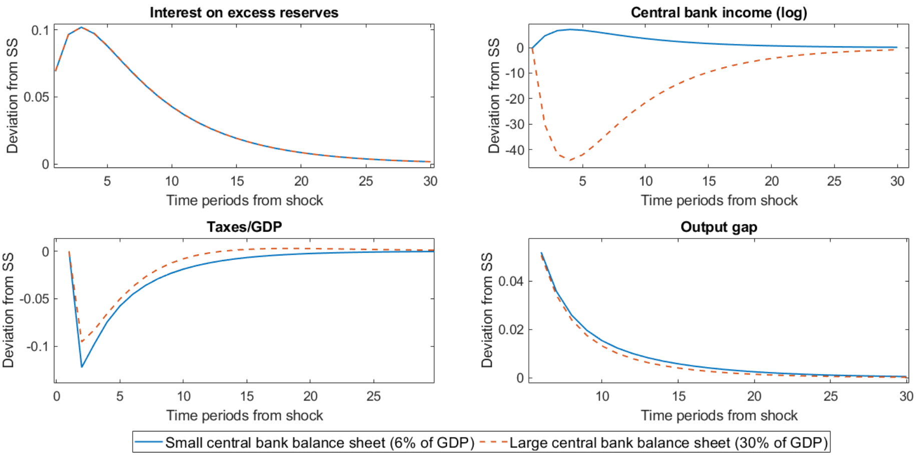


Figure: “Fiscal effect” of central bank net income

Periods of stability in the Fed's balance sheet

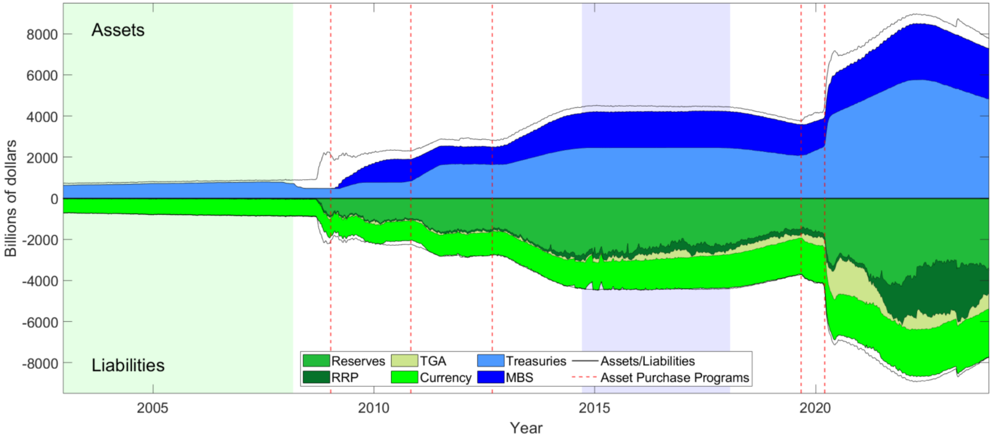


Figure: Periods of relative stability in size of CB balance sheet

Point estimate of 2018 results compared to 2005

Table: Cum. fluctuations from 1% log deviation

Shock	Output Gap	Inflation
ξ_t	4.5% lower	3.4 % lower
A_t	2.07 % higher	7.8 % lower

Table: Gov. spending shock 1% of GDP

Shock	Output Gap	Inflation
F_t	0.54% lower	1.08% lower

- 1% gov spending shock is bigger in 2018 economy ($\gamma^{2018} = .22 > .2 = \gamma^{2005}$)

Concluding remarks

- This paper:
  1. analyzes the central bank problem at time t
  2. model the correlation between policy rates and central bank income
- Key Findings:
  1. under abundant reserves, central bank income amplifies the real effects of interest rate policy in the NK model
  2. swings in central bank income have different implications for the fiscal authority's budget constraint, which has real impacts ($\sim 4\%$ of the cycle)
- Conclusion: A policy setting committee ignoring central bank income would be a mistake
  - coefficients of monetary rules could be miscalibrated
  - central bank income is a factor to consider when evaluating interest rate decisions

Works Cited I

- Alvarez and Jermann (2004). "Using Asset Prices to Measure the Cost of Business Cycles". *Journal of Political Economy* 112 (6), pp. 1223–1256.
- Barlevy (2004). "The Cost of Business Cycles Under Endogenous Growth". *American Economic Review* 94 (4), pp. 964–990.
- Barro (1979). "On the Determination of the Public Debt". *Journal of Political Economy* 87, pp. 940–971.
- Bhattarai, Eggerston, and Gafarov (2022). "Time Consistency and the Duration of Government Debt: A Model of Quantitative Easing". *Review of Economic Studies* 0, pp. 1–41.

Works Cited II

Bianchi and Bigio (2022). "Banks, liquidity management, and monetary policy". *Econometrica* 90 (1), pp. 391–454.

Lucas (2003). "Macroeconomic Priorities". *American Economic Review* 93 (1), pp. 1–14.

Poole (1968). "Commercial Bank Reserve Management in a Stochastic Model: Implications for Monetary Policy". *The Journal of Finance* 23 (5), pp. 769–791.

Rotemberg (1982). "Sticky Prices in the United States". *Journal of Political Economy* 90, pp. 1187–1211.

Nominal Central Bank Net Income

(return)

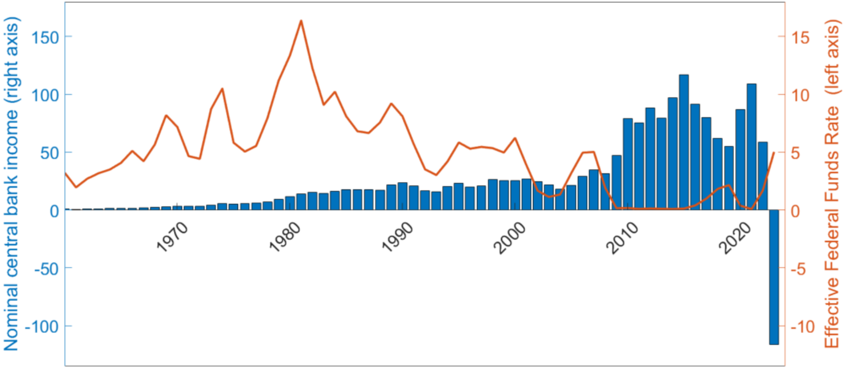
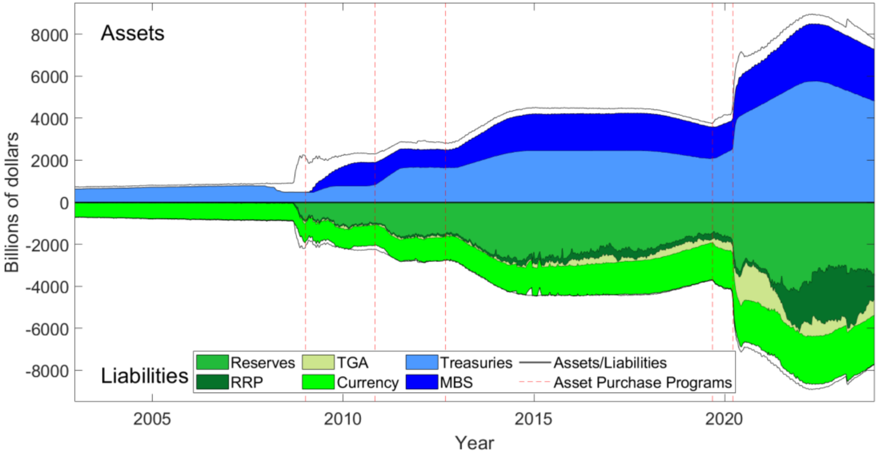


Figure: Federal Reserve profits and federal funds rate

Federal Reserve Balance Sheet (scarce vs. abundant reserves)



return

Correlation is not a coincidence

(return)

- Balance Sheet of the Federal Reserve:
  - **(1)** pre-QE: $B_t^{CB} = M_t$
  - **(4)** post-QE: $B_t^{CB} + B_t^{CB,QE} = M_t + RE_t$

	Scarce reserves/ FF targeting	Abundant reserves/ Administered rates
Assets: Short Duration	**(1)** $i_t^{short} - 0$ $Corr(i_t^{policy}, CBI_t) > 0$	**(2)** $i_t^{short} - i_t^{policy}$ $Corr(i_t^{policy}, CBI_t) \sim 0$
Assets : Long Duration	**(3)** $i_t^{long} - 0$ $Corr(i_t^{policy}, CBI_t) >\sim 0$	**(4)** $i_t^{long} - i_t^{policy}$ $Corr(i_t^{policy}, CBI_t) < 0$

Table: Central Bank return on assets correlation to the policy rate

Framing the balance sheet assumption

(return)

- why am I imposing a strong constraint and not others?
  - a policy maker at time t inherits a condition on the balance sheet and interest rate levels
  - economy hit with a shock....what should the policy response be?
  - interest rate policy: option to raise interest rates from ZLB to 10% in one day with administered rates (unlimited flexibility)
  - can not alter the size of the balance sheet drastically in the short term
    - they did this in COVID, but was dependent on a LARGE fiscal shock which the Fed monetized
  - since interest rate policy is the primary short term counter-cyclical tool, we keep that flexible and the balance sheet fixed

Representative Household (return)

$$\max_{\{c_t(i), h_t(i), D_t\}_{t=0}^{\infty}} E_t \sum_{t=0}^{\infty} \beta^t \left(\frac{C_t^{1-\sigma} - 1}{1-\sigma} - \psi \frac{H_t^{1+\chi}}{1+\chi} \right) \xi_t$$

$$P_t C_t + P_t T_t + D_t \leq W_t H_t + (1 + i_{t-1}^d) D_{t-1} + \int_0^1 \phi_t^{firm}(i) di + \phi_t^{FI}$$

$$log(\xi_t) = \rho_a log(\xi_{t-1}) + \varepsilon_t^{\xi}$$

- Standard NK set-up and euler equation
- Saving through deposits at financial intermediary
- Own the firms and intermediary
- Preference shock ξ_t on entire utility function

Firms producing differentiated goods (return)

$$\max_{\{p_t(i)\}_{t=0}^{\infty}} E_t \sum_{j=0}^{\infty} \mathcal{D}_{t,t+j} \left(p_{t+j}(i) y_{t+j}(i) - w_{t+j}(i) \frac{y_{t+j}(i)}{A_{t+j}} - \frac{\varphi}{2} \left(\frac{p_{t+j}(i)}{\pi^* p_{t+j-1}(i)} - 1 \right)^2 Y_{t+j} P_{t+j} \right)$$

$$y_t(i) = A_t h_t(i)$$

$$log(A_t) = \rho_a log(A_{t-1}) + \varepsilon_t^A$$

$$\mathcal{D}_{t,t+j} = \beta^j [U_c(t+j)/U_c(t)]$$

- Simple NK-set up and phillips curve
- Nominal price frictions as in Rotemberg 1982
- Constant returns to scale production in labor
- A_t used for aggregate supply shock

Monetary policy (return)

- Central bank sets the interest rate on excess reserve balances in a Taylor type rule

$$i_t^{ioer} = \mu_i i_{t-1}^{ioer} + (1-\mu_i)\left[(i^{ioer})^{ss} + \mu_\pi(\pi_t - \pi^*) + \mu_y\left(\frac{Y_t - Y^N}{Y^N}\right)\right]$$

- Central bank balance sheet

$$\underbrace{B_t^{CB} + L_t^{CB}}_{Assets} = \underbrace{\Lambda P_t Y_{ss} + \lambda P_t Y_{ss}}_{Assets} = \underbrace{RE_t}_{Liabilities}$$

- Central bank income $(CBI_t) \sim \Lambda P_t Y_{ss}(i_t^{bill} - i_t^{ioer}) + \lambda P_t Y_{ss}(i_{ss}^{bond} - i_t^{ioer})$
- Counterfactuals between different λ-economies (QE purchases of long term bonds)

Fiscal sector (return)

- Spending and taxes are constant fractions γ, τ of output

$$F_t = (1-\rho_F)\gamma Y_{ss} + \rho_F F_{t-1} + \varepsilon_t^F$$

$$T_t = \tau Y_t + \phi_B \left(\frac{(B_{t-1}^{FI} + L_{t-1}^{FI})/P_t}{Y_t} - \frac{(B_{ss}^{FI} + L_{ss}^{FI})/P}{Y^{ss}} \right)$$

- Convex output costs to taxation as in Barro 1979, Bhattarai et al. 2022

$$F_t = G_t + s(T_t)$$

- Bond issuance governed by a constant maturity structure $\Omega = B_t/(L_t + B_t)$

$$Expenditures : P_t G_t + (1 + i_{t-1}^{bill}) B_{t-1} + (1 + i_{ss}^{bond}) L_{t-1}$$

$$Income : P_t T_t + B_t + L_t + \Delta_{LCR}(\zeta D_t - RE_t - B_t^{FI}) + CBI_t$$

Financial intermediary problem (return)

- Maximize expected profits under deposit withdraw uncertainty Z_t as in Poole 1968

$$\max_{\{B_t^{FI}, L_t^{FI}, RE_t\}} E_t \sum_{t=0}^{\infty} \beta^t \left((1 + i_{t-1}^{bill}) B_{t-1}^{FI} + (1 + i_{ss}^{bond}) L_{t-1}^{FI} + (1 + i_{t-1}^{irr}) \alpha D_{t-1} - (1 + i_{t-1}^{d}) D_{t-1} + \Xi_{t-1} \right)$$

$$Z_t D_t = B_t^{FI} + RE_t + L_t^{FI}$$

$$RE_t \geq \alpha D_t$$

$$RE_t + B_t^{FI} \geq \zeta D_t$$

$$i^{irr} = 0$$

- Costs of deposit withdraw uncertainty Ξ_t with $Z_t \sim lognormal(0, \sigma_Z^2)$
  1. excess reserves or reserve deficiency Reserve requirement constraint uncertainty
  2. surplus or deficient high quality liquid assets LCR constraint uncertainty

Financial intermediary problem under Poole 1968 uncertainty (Full FI problem)

- Balance sheet constraint:

$$\underbrace{Z_t D_t}_{Liabilities} = \underbrace{RE_t + B_t^{FI} + L_t^{FI}}_{Assets}$$

- Reserve requirement violation cost Δ_{DW}:

$$RE_t \geq \alpha D_t$$

- Liquidity coverage ratio violation cost Δ_{LCR}:

$$RE_t + B_t^{FI} \geq \zeta D_t$$

- Portfolio choice problem:
  - $RE_t \rightarrow (i_t^{rr}, i_t^{ioer}) +$ LCR constraint + reserve requirement
  - $B_t^{FI} \rightarrow i_t^{bill} +$ LCR constraint
  - $L_t^{FI} \rightarrow i_{ss}^{bond}$

Reserve requirement: $RE_t \geq \alpha D_t$ (return)

$$\Xi_t = (1 + i_t^{ioer}) \underbrace{\int_{\frac{B_t^{FI} + L_t^{FI}}{(1-\alpha)(B_t^{FI} + L_t^{FI} + RE_t)}}^{Z^U} (RE_t + (D_t Z_t - D_t) - \alpha D_t Z_t) f(Z_t) dZ_t}_{\text{Bank holds excess reserves}}$$

$$+ (1 + i_t^{ioer} + \Delta_{DW}) \underbrace{\int_0^{\frac{B_t^{FI} + L_t^{FI}}{(1-\alpha)(B_t^{FI} + RE_t + L_t^{FI})}} (RE_t + (D_t Z_t - D_t) - \alpha D_t Z_t) f(Z_t) dZ_t}_{\text{Deposit withdraws cause reserve deficiency}}$$

- For which value of Z_t do excess reserves $=0$?

$$\underbrace{\alpha D_t Z_t}_{\text{Required reserves after payments shock}} = \underbrace{RE_t + (D_t Z_t - D_t)}_{\text{Total reserves after payments shock}} \implies Z_t = \frac{B_t^{FI} + L_t^{FI}}{(1-\alpha)(B_t^{FI} + RE_t + L_t^{FI})}$$

Liquidity coverage ratio: $RE_t + B_t^{FI} \geq \zeta D_t$ (return)

- For which value of Z_t does the LCR bind?

$$\underbrace{RE_t + B_t^{FI} + (D_t Z_t - D_t)}_{\text{HQLA after payments shock}} = \underbrace{\zeta D_t}_{\text{HQLA required to avoid a fine}}$$

$$Z_t = 1 + \zeta - \frac{RE_t + B_t^{FI}}{B_t^{FI} + L_t^{FI} + RE_t}$$

$$\Xi_t = ... + \Delta_{LCR} \underbrace{\int_0^{1+\zeta-\frac{RE_t+B_t^{FI}}{B_t^{FI}+L_t^{FI}+RE_t}} (RE_t + B_t^{FI} + (D_t Z_t - D_t) - \zeta D_t) f(Z_t) dZ_t}_{\text{Deposit withdraws LCR violation}}$$

Baseline Calibration (return)

Table: Model Specific Parameters

Parameter	Value	Description	Source
β	.992	Discount factor	3 month CD $\sim$ 5.32% (OECD)
λ	[0,.3]	ratio of QE purchases to SS GDP	comparative statics
Λ	.06	pre-QE ratio of CB assets to SS GDP	
γ	.2	SS (gov. spending/GDP)	USA average
τ	.217	SS (taxes/GDP)	FI Model Moments
Ω	.2	(Fixed rate bond)/(Tbills) ratio	2024 USA ratio
α	.05	"Reserve Requirement"	excess reserves $\sim$ 0 for $\lambda = 0$
Δ_{DW}	.004/4	DW spread to IOER	full sample average
Δ_{LCR}	.004/4	LCR penalty	$= \Delta_{DW}$
σ_z^2	.12	Deposit Volatility	Bianchi and Bigio 2022
ζ	.2	LCR	min s.t LCR never violated
ϕ_B	.18	Tax/bond issuance rule	min s.t $\exists$ convergence
ϕ_T	.2	Output costs to taxation	model mechanism $>>>$ reserve demand
ϕ_π	1.5	Taylor coefficient on inflation	Taylor Principle
ϕ_y	.125	Taylor coefficient on output	ε_t^F inflationary

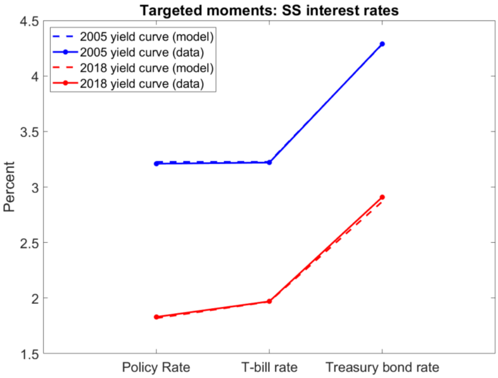
Calibration - an overview (Externally calibrated, Internally calibrated)

- Model is calibrated to match the US 2005 and 2018 economies (Calibration ratios)
  - late stage expansion, no inverted yield curves

Table: Counterfactual calibration

Parameter	Target	2005 Value	2018 Value
λ	(QE purchases)/GDP	0%	15%
α	Currency/(Fed Liabilities)	97%	39%
γ	(Gov. spending)/GDP	20%	22%
τ	Debt/GDP	51%	100%
Ω	Tbills/(Treasury Debt)	0.14	0.1
β	Deposit rate	3.5%	2.2%
$(\Delta_{DW}, \Delta_{LCR})$	10yr - 3 month spread	1.07%	94 bps
σ_z^2	3 month - FF spread	0 bps	14 bps
ζ	$\zeta D_t \leq RE_t + B_t^{FI}$	.14	.251

Calibration results



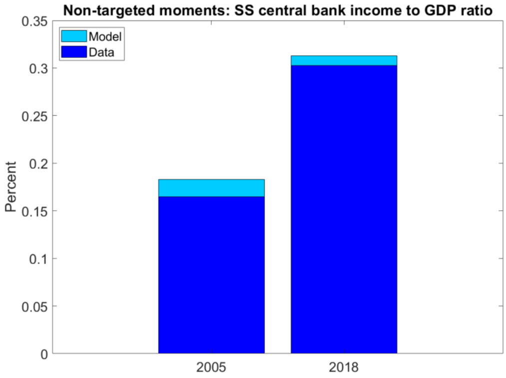


Figure: Targeted and non-targeted moments (Calibration results)

Steady state bonds calibration

return

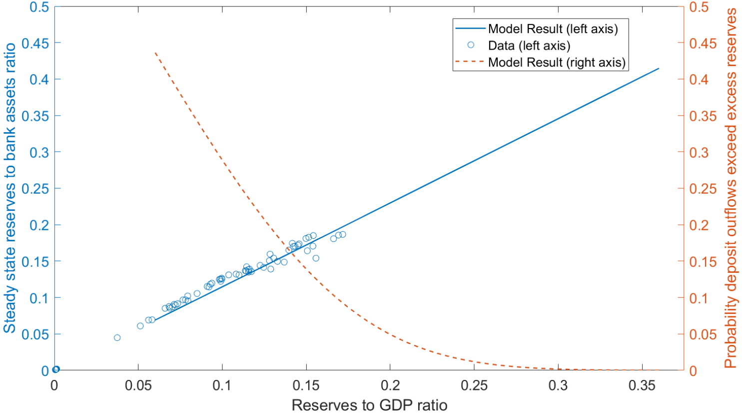


Figure: Matching bank balance sheet reserve/assets ratios

Measurement of aggregate fluctuations compared to baseline

return

- i = type of AR(1) shock (A_t, ξ_t, G_t)
- $X_{t,i}$ = impulse response function series: $\pi_{t,i}$, $Y_{t,i}$
- $RE_t = \lambda Y_{ss}$
- baseline (pre-GFC) Fed Balance Sheet is 6% of GDP

$$Deviations_{\lambda,i} = \frac{\sum_{t=0}^{\infty} |X_{t,i} - X_{ss}|_{\lambda} - \sum_{t=0}^{\infty} |X_{t,i} - X_{ss}|_{\lambda=0}}{\sum_{t=0}^{\infty} |X_{t,i} - X_{ss}|_{\lambda=0}}$$

$$\frac{\text{(Area under the } \lambda > 0 \text{ IRF) - (Area under the } \lambda = 0 \text{ economy IRF)}}{\text{(Area under the } \lambda = 0 \text{ economy IRF)}}$$

- % difference in fluctuations in prices/output compared to an economy with a CB BS size of 6% GDP?

Duration of publicly held treasuries vs. Fed holdings

return

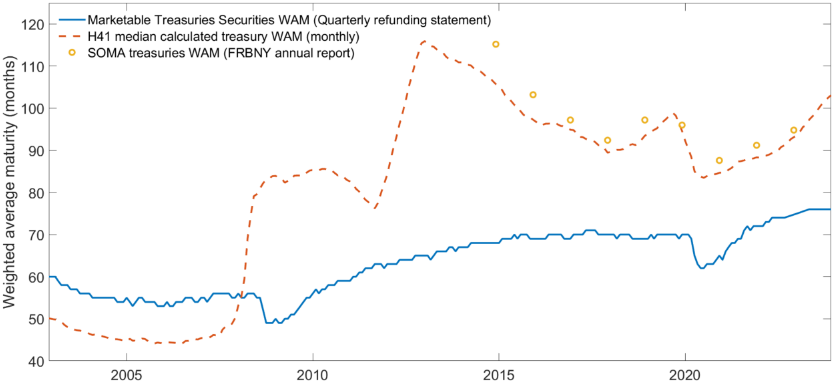


Figure: SOMA Treasury WAM vs Market

"Steady state" economies: 2005 vs 2018 (return)

- Model is calibrated to match four ratios, plus the slope and level of the yield curve

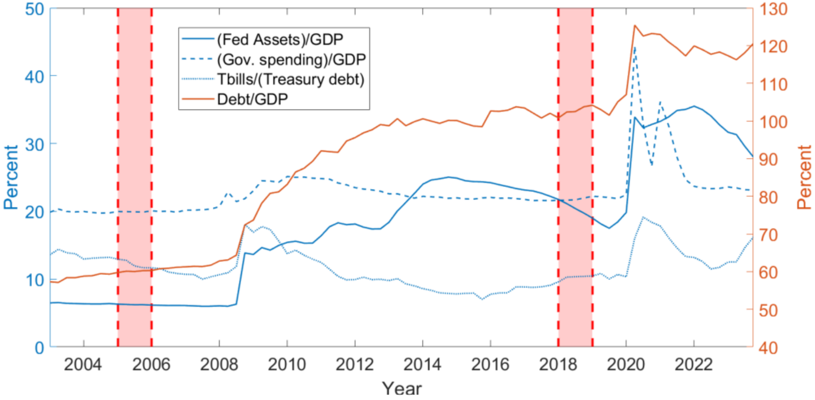


Figure: Calibrated steady states

Externally calibrated parameters

(return)

Table: Externally calibrated parameters

Parameter	2005	2018	Description	Source
λ	0	.15	ratio of QE asset holdings to SS GDP	H41, BEA
Λ	.06	.06	ratio of pre-QE asset holdings to SS GDP	H41, BEA
γ	.2	.22	SS (gov. spending/GDP)	BEA
Ω	.14	.1	(Tbills)/(total debt) ratio	MSPD
Δ_{DW}	.00975/4	.0053/4	DW spread to FF	H15, NY fed
ϕ_B	.2	.2	Tax/bond issuance rule	
ϕ_T	.1	.1	Output costs to taxation	
ϕ_π	1.5	1.5	Taylor coefficient on inflation	Taylor Principle
ϕ_y	.125	.125	Taylor coefficient on output	ε_t^G inflationary

Model Calibration (return)

Table: 2005 counterfactual calibration

Parameter	Value	Description	Source
β	.99956	discount factor	level of yield curve
τ	.20225	SS (taxes/GDP)	Debt/GDP $\sim$ 51%
α	.112	"Currency" (reserve) Requirement	(Currency/CB Liabilities) $\sim$ 97 %
ζ	.14	LCR	$\max_{\zeta}$ s.t $\zeta D_t \leq RE_t + B_t^{FI}$
Δ_{LCR}	.0212/4	LCR penalty	(10yr - 3 month spread) $\sim$ 1.07%
σ_z^2	.001	Deposit Volatility	3 month - FF spread $\sim$ 0bps

Table: 2018 counterfactual calibration

Parameter	Value	Description	Source
β	.9988	discount factor	level of yield curve
τ	.22115	SS (taxes/GDP)	Debt/GDP $\sim$ 100%
α	.0815	"Currency" (reserve) Requirement	(Currency/CB Liabilities) $\sim$ 39 %
ζ	.251	LCR	$\max_{\zeta}$ s.t $\zeta D_t \leq RE_t + B_t^{FI}$
Δ_{LCR}	.018/4	LCR penalty	(10yr - 3 month spread) $\sim$ 98bps
σ_z^2	.26	Deposit Volatility	3 month - FF spread $\sim$ 16 bps

Model vs Data

(return)

Table: Targeted moments

Moment	Data (2005)	Model (2005)	Data (2018)	Model (2018)
(Fed Assets)/GDP	.06	.06	.21	.21
(Treasury bills)/(Treasury debt)	.14	.14	.1	.1
(Government spending)/GDP	.2	.2	.22	.22
(Government debt)/GDP	.51	0.51	1.02	0.99
10 year - 3 month spread	.0107	.0108	.0094	.0092
3 month - policy rate spread	0	0	.0014	.0015
(Currency)/(Fed liabilities)	.97	.95	.39	.39

Table: Non-targeted moments

Moment	Data (2005)	Model (2005)	Data (2018)	Model (2018)
Deposit rate	.035	.038	.022	.025
(Central bank income)/GDP	.0016	.0018	.003	.0031
(Central bank income)/receipts	.01	.009	.019	.014

Interpretation of results

For a 1% preference shock:

- abundant reserves economy experiences cumulative fluctuations that are 4.5% lower in output, and 3.5% lower in inflation compared to the scarce reserves
  - Recessions/expansions are $\sim$ 4% smaller in economies with a large central bank balance sheet
- Lucas 2003 $\rightarrow$ Barlevy 2004, Alvarez and Jermann 2004
  - $\sim$ 4% of the cycle
  - $30 trillion economy w/ 1% recession $\rightarrow$ $300 billion in lost output
  - $30 trillion economy w/ .96% recession $\rightarrow$ $288 billion in lost output
    - $12 billion difference in GDP based on central bank balance sheet size and income
- Results with deferred asset accounting

Federal Reserve deferred asset (DA) accounting (return)

1. Profits: remit positive net income to the treasury department
2. Losses: book a negative liability "deferred asset" as an IOU to treasury
   - Fed DA currently $\sim$ \$216 billion
3. $CB_t^{transfer} = max\{CBI_t + DA_t^-, 0\}$

$$DA_t = \begin{cases} 0 & \text{if } DA_{t-1} + CBI_t \geq 0 \\ DA_{t-1} + CBI_t & \text{if } DA_{t-1} + CBI_t < 0 \end{cases} \tag{1}$$

$$\underbrace{B_t^{CB} + L_t^{CB}}_{Assets} = \underbrace{RE_t + DA_t^-}_{Liabilities} \tag{2}$$

2018 economy counterfactual (return)

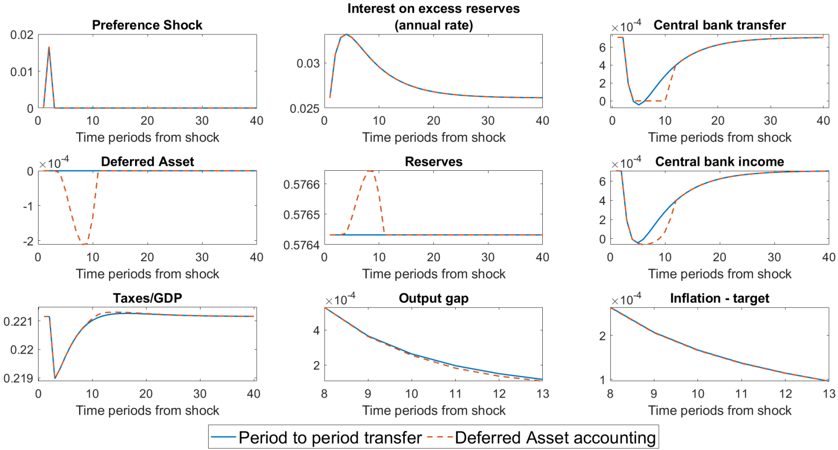


Figure: Period-to-period transfer vs. deferred asset accounting

Analysis of DA policy (return)

$$\underbrace{B_t^{CB} + L_t^{CB}}_{Assets} = \underbrace{RE_t + DA_t^-}_{Liabilities}$$

- faces negative net income with no fiscal support
- prints money ($+RE_t$) to pay for its losses ($-DA_t$)

$$\underbrace{(=)B_t^{CB} + (=)L_t^{CB}}_{(=)Assets} = \underbrace{(\uparrow)RE_t + (\downarrow)DA_t^-}_{(=)Liabilities}$$

- lower central bank income and higher path for taxes across the cycle
- DA accounting procedures do not mitigate this channel of monetary policy