Central Bank Balance-Sheet Policies: A Comparative Statics Approach

8th ChaMP Workshop

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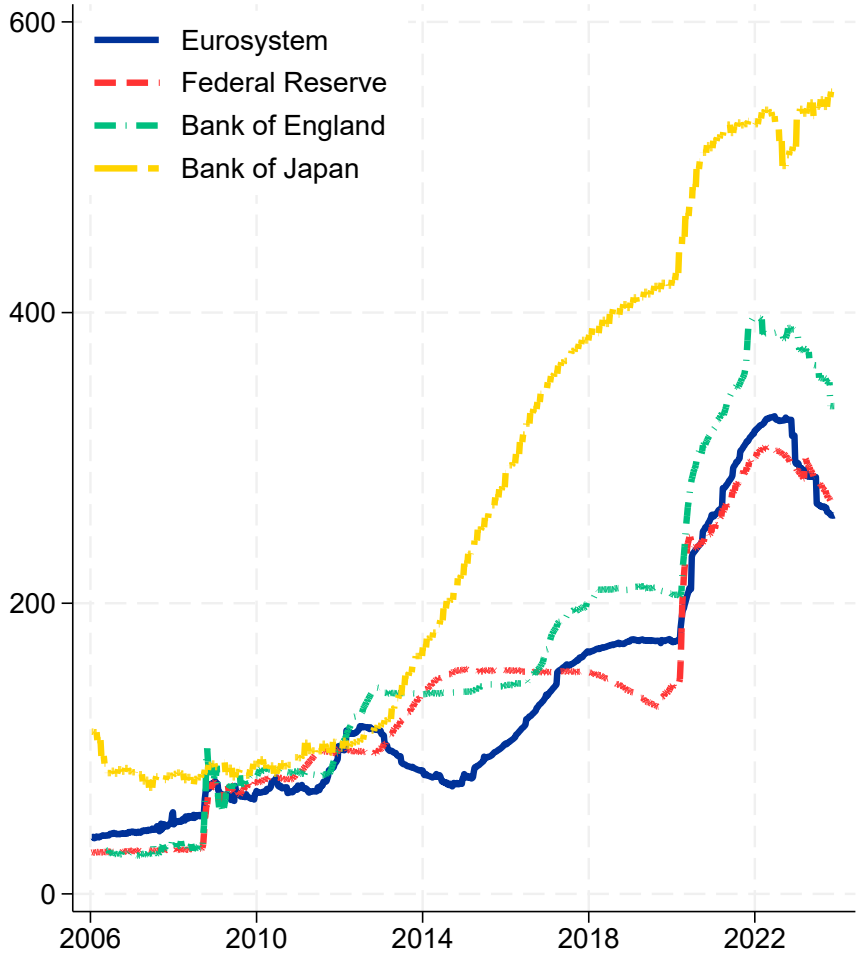
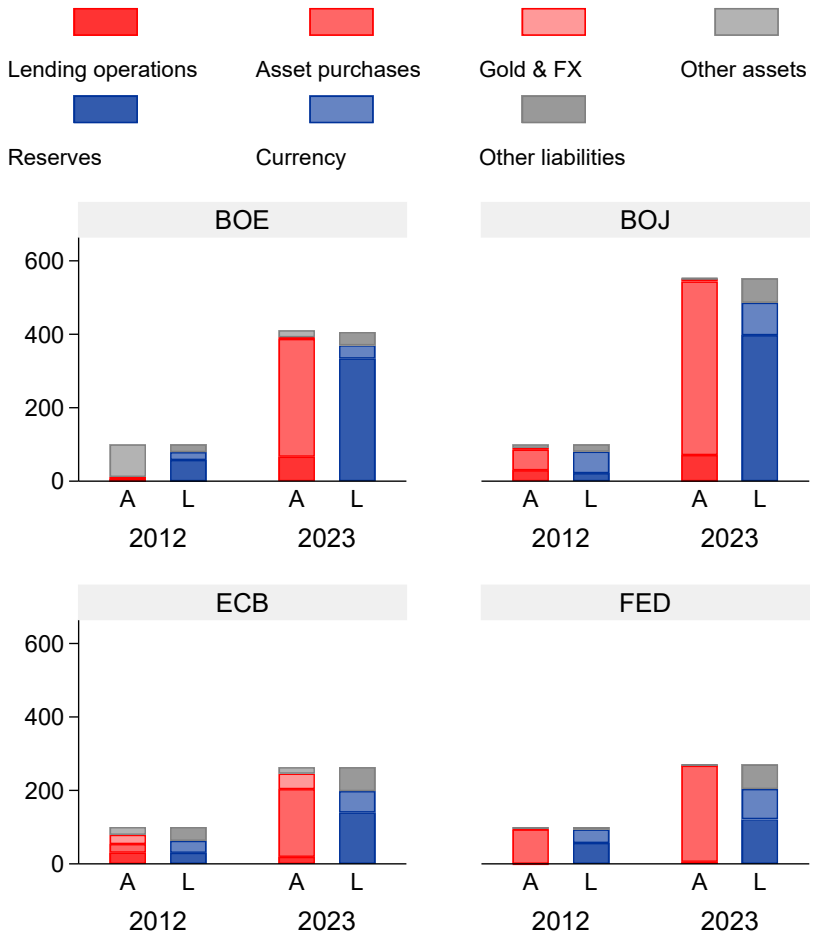
Introduction

> Large Balance Sheets





Total Asset Holdings of Major Central Banks

> Motivation

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- In fact, various mechanisms:
  - risk concentration/financial constraints (Gertler-Karadi, Vayanos-Vila)
  - liquidity-premia (Bianchi-Bigio)
  - fiscal consequences (Benigno-Benigno)
  - signalling (Eggertson et al.)

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  - signalling (Eggertson et al.)
- Challenge: understand relevance of each channel

> Goal

- Interest rate:
  - well established framework: New-Keynesian model
  - key statistics:
    - intertemporal elasticity of substitution
    - slope of Phillips curve
    - MPC distribution (HA version)
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- **Goal: counterpart for QE**
  - produce **sufficient statistics** that summarize the relevance of each channel
  - **quantitative assessment**
  - focus: **comparative-statics** analysis (shut down feedback effects from expectations about future)

> Questions

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  - stimulate credit?
  - translate to inflation?
- Which statistics govern the strength of these effects?
  - elasticities of funding sources or investment opportunities for banks?
  - elasticities of premiums generated by risk, liquidity or regulation?

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- Common outside macro-finance
  - taxation, international trade
  - heterogeneous agents, welfare analysis

Framework

* Environment (non-bank block)
* Banks Problem
* Equilibrium

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* focus on static $t = 0$ effects
  * anchored inflation expectations

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$$R^x = \frac{1 + i^x}{1 + \pi}$$

* Quantities:
  * lower-case: real
  * upper case: nominal

> Non Banking: Asset Demand System

* critical: segmentation
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Demand System

Deposit supply:

$$d\left(R^d\right)$$

Loan demand:

$$\ell\left(\bar{R}^\ell, P\right)$$

* Key elasticities:
  * $\epsilon^d > 0$: captures external funding elasticity for banks
  * $-\epsilon^\ell_R < 0$: captures elasticity of investment schedule for banks
  * $\epsilon^\ell_P > 0$: summarizes sticky wages + payroll financing channel

> Central Bank

* Standard Instrument (corridor for interest rate):

$$i^m \to R^m \equiv \frac{1+i^m}{1+\pi}, \quad i^{dw} \to R^{dw} \equiv \frac{1+i^{dw}}{1+\pi}$$

* Central Bank Balance sheet

$$\frac{L^g}{P} = \frac{M}{P} + \overbrace{e^g}^{=0}$$

* Income statement ($t = 1$)
  * return on portfolio (risky) | discount-window loans - interest paid on reserves
    $\Rightarrow$ real transfers to households / banks
  * nominal transfers chosen to meet inflation target
  * Key: fraction of transfers going to households $\varphi \in [0, 1]$
    $\Rightarrow$ governs risk-absorption channel
* QE (policy rates fixed):

$$dM = dL^g$$

> Remarks

* $\frac{dP}{P}$ is not expected inflation (tomorrow):

$$\frac{P'}{P} = (1+\pi) \rightarrow d\left(\frac{P'}{P}\right) = 0.$$

* $\frac{dP}{P}$ is counterfactual surprise in price (today)

$$\frac{dP}{P}$$

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> Bank's Problem

* Bank maximizes:

$$\max_{\{\ell^b, m^b, d^b, div_0\}} u(div_0) - \underbrace{\beta\Lambda\left(\frac{d^b - m^b}{\ell^b}\right)\ell^b}_{\text{Leverage cost}} + \beta\mathbb{CE}(div_1(\omega, z))$$

budget:

$$div_0 + \ell^b + m = \underbrace{e^b(P)}_{\text{nominal contracts}} + d$$

$$div_1(\omega, z) = \underbrace{R^\ell(z)\ell^b + R^m m^b - R^d d^b}_{\text{Expected Portfolio Returns}} + \underbrace{\chi(s(\omega)|\theta)}_{\text{Settlement Return}} + \frac{T_1^b(z)}{P(1+\pi)}$$

* Uncertainty: z return on loan portfolio (aggregate), ω liquidity risk (idiosyncratic)
* Liquidity shocks: depositors transfer funds from one bank to another.

> Bank's Problem | Liquidity risk

* The reserve surplus after the deposit transfers:

$$s = \begin{cases} m^b - \delta d^b & \text{with prob. } 0.5 \\ m^b & \text{with prob. } 0.5 \end{cases}$$

* Endogenous liquidity cost

$$\chi(s;\theta) = \begin{cases} \chi^-(\theta) \cdot s & \text{if } s \leq 0 \\ \\ \chi^+(\theta) \cdot s & \text{if } s > 0 \end{cases}$$

* Tightness (interbank)

$$\theta = -\underbrace{\frac{\overbrace{M/P - \delta d}^{\text{deficit}}}{M/P}}_{\text{surplus}}$$

* $\chi(s;\theta)$ related to tightness: $R^{int}(\theta)$ endogenous interbank rate, $\psi^-(\theta)$ discount-window access.

> Bank's Problem | Optimal decisions

* FOCs

$$[\ell^b] : \bar{R}^\ell = R^f + \underbrace{\gamma\sigma^2\left(\bar{R}^\ell\right)^2\left(\ell^{b,i} + (1-\varphi)\frac{L^g}{P}\right)}_{\text{risk premium } \mathcal{RP}} - \underbrace{\left(\Lambda'\left(k^i\right)k^i - \Lambda\left(k^i\right)\right)}_{\text{balance sheet service } \mathcal{B}^a(k^i)}$$

$$[m^b] : R^m = R^f - \underbrace{\frac{1}{2}\left[\chi^+(\theta) + \chi^-(\theta)\right]}_{\text{liquidity service } \mathcal{L}^m} - \underbrace{\Lambda'\left(k^i\right)}_{\text{balance sheet cost } \mathcal{B}^d(k^i)}$$

$$[d^b] : R^d = R^f - \underbrace{\frac{\delta}{2}\chi^-(\theta)}_{\text{liquidity risk } \mathcal{L}^d} - \underbrace{\Lambda'\left(k^i\right)}_{\text{balance sheet cost } \mathcal{B}^d(k^i)}$$

where $R^f \equiv \beta^{-1}u'\left(div_0^j\right)$ and $k^i \equiv \frac{d^{b,i}-m^{b,i}}{\ell^{b,i}}$.

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> Market clearing

* Reserves

$$\int m^{b,i} di = \frac{M}{P}$$

* Loans

$$\ell^g + \int \ell^{b,i} di = \ell(\bar{R}^\ell, P)$$

* Deposits

$$\int d^{b,i} di = d(R^d)$$

> Equilibrium characterization

Given policy decisions for $\{i^m, i^{dw}, \pi, \varphi, M\}$, the following system determines aggregate loans ℓ, deposits d, price level P

$$\begin{aligned} \bar{R}^{\ell}(\ell, P) &= R^f + \gamma \mathbb{V}\left(R^{\ell}\right)\left(\ell - \varphi \frac{L^g}{P}\right) - \mathcal{B}^a(k) \\ R^m &= R^f - \mathcal{L}^m(\theta) - \mathcal{B}^d(k) \\ R^d(d) &= R^f - \mathcal{L}^d(\theta) - \mathcal{B}^d(k) \end{aligned}$$

where central bank purchases are

$$M = L^g$$

and

$$k \equiv \frac{d - \frac{M}{P}}{\ell - \frac{L^g}{P}} \text{ is leverage, } \theta \equiv\text{-} \frac{M/P - \delta d}{M/P} \text{ is market tightness,}$$

$\bar{R}^{\ell}(\ell, P)$ is defined by firms' loan demand, $R^d(d)$ is defined by the representative household's deposit supply, $R^f \equiv \beta^{-1} u'(div_0)$, $\mathbb{V}\left(R^{\ell}\right) = \sigma^2 \left(\bar{R}^{\ell}(\ell, P)\right)^2$, aggregate dividends are $div_0(P, d, \ell) \equiv d - \ell + e(P)$.

> Differential system

QE Effects

Consider QE $\mathrm{d}L^{g} = \mathrm{d}M$. Then

$$\mathcal{A}(\Theta, \Omega) \times \begin{bmatrix} \frac{\mathrm{d}d}{d} \\ \frac{\mathrm{d}P}{P} \\ \frac{\mathrm{d}\ell}{\ell} \end{bmatrix} = \mathcal{D}(\Theta, \Omega) \times \frac{\mathrm{d}M}{M}.$$

Replace budget constraints, take differentials

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* Key Financial ratios and returns/ premiums Ω:

$$\ell, \ell^{g}, m, d, e, div$$

$$R^{\ell}, R^{d}, R^{m}, \mathcal{L}^{m}, \mathcal{L}^{d}, \mathbb{V}(R^{\ell}), \mathcal{B}^{a}, \mathcal{B}^{d}$$

> Financial frictions and nominal rigidities

Neutrality: no financial frictions

Absent financial frictions: - no leverage constraint $\epsilon_k^{\mathcal{B}^a} = \epsilon_k^{\mathcal{B}^d} = 0$
- satiation in the interbank market $\epsilon_\theta^{\mathcal{L}^m} = \epsilon_\theta^{\mathcal{L}^d} = 0$
- no risk absorption of government purchases $\varphi = 0$
Then, asset purchases $\mathrm{d}L^g$ are neutral. Moreover, the price level does not respond to OMO.

Neutrality: no nominal rigidities

Absent nominal rigidities:
- no sticky wages $\epsilon_P^\ell = 0$
- real financial contracts $\epsilon_P^e = 0$
Then, asset purchases $\mathrm{d}L^g$ are neutral. the price level adjusts proportionally to the change in reserves, i.e., $\mathrm{d}P/P = \mathrm{d}M/M$.

> Funding and investment elasticities

Neutrality: perfectly inelastic funding /investment

Under perfectly inelastic funding (deposits, equity) and investment (loans) elasticities

$$\psi, \epsilon^{d}, \epsilon^{\ell}_{R} \to 0$$

Asset purchases $\mathrm{d}L^{g}$ are neutral.

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Under perfectly inelastic funding (deposits, equity) and investment (loans) elasticities

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> Summary of real effects

Real Effects over aggregate credit

		Nominal Rigidity		
		None	Nominal assets	Sticky wages
Financial Friction	None	N	N	N
	Liquidity friction	N	(-)	(+)
	Risk absorption	N	(+)	N
	Balance sheet constraint	N	(-)	(+)

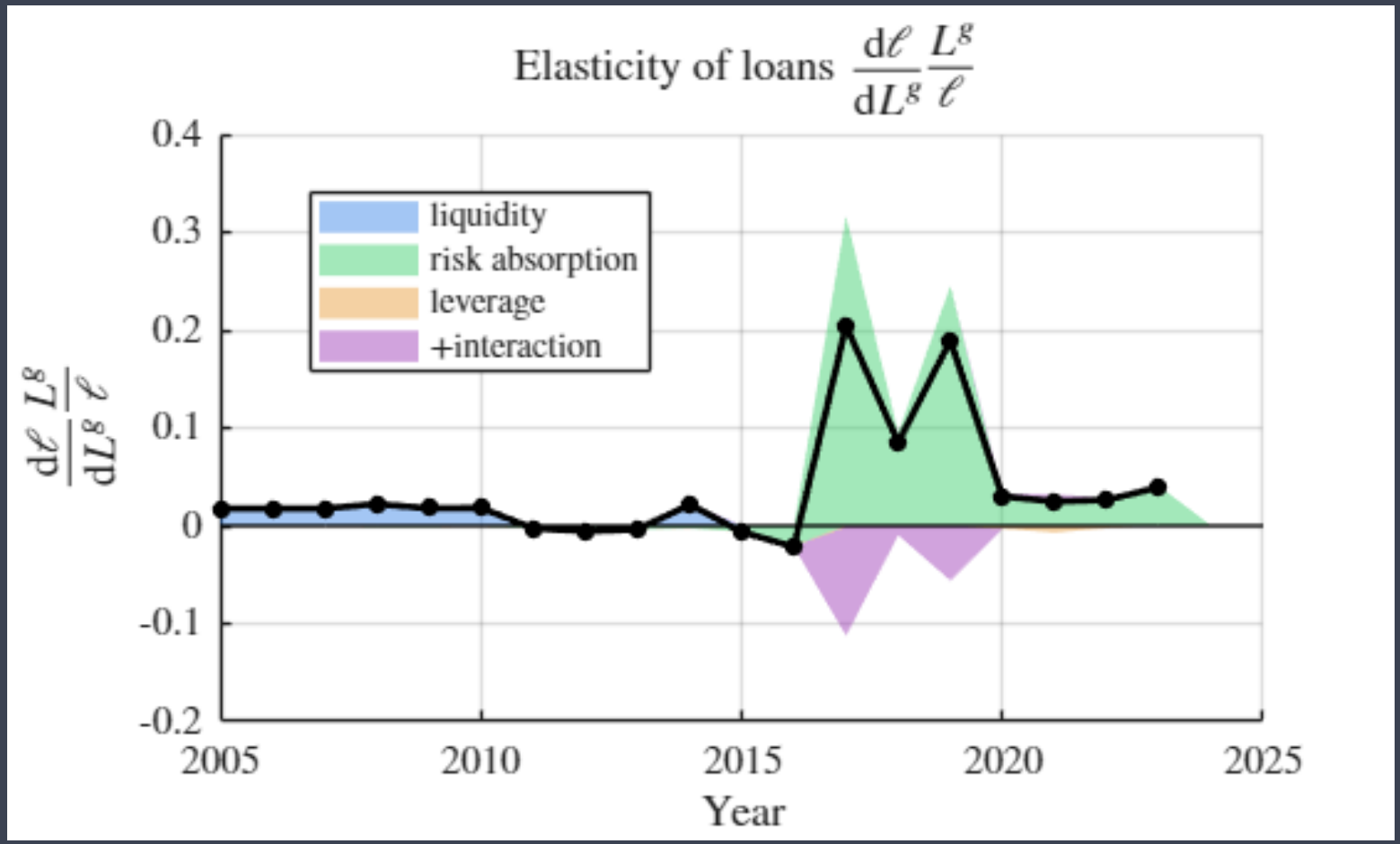
- Elasticities govern strengths when operation not neutral
- Signs under additional assumptions (and finite investment / funding elasticities)

Quantitative exercises

> Work in progress

* Measure the key statistics (ECB data)
* Time series of potential effects of QE at different points in time
* Decomposition of relative importance of each channel
* Quantitative analysis of how the strength of each channel depends elasticities

> Work in progress



Example quantitative exercise

* Liquidity channel absent when interbank market flooded with reserves

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* Presented a framework to think about unconventional MP
  * framework focused on short-run comparative statics
  * flexible to accommodate various considerations
* End goal
  * identify key-elasticities
  * estimate and build a tool to evaluate QE