Lecture: Central-Bank Balance Sheet Policies: comparative statics

by

on February 14, 2024

Intro

> An anecdote

"The problem with QE is it works in practice, but it doesn't work in theory."
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- Divorce within Central Bank units
  - Forecast Units: DSGE modeling
  - Operations: fine-tune QE and policy rate
  - Supervision: balance-sheet stats

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- Divorce within Central Bank units
  - Forecast Units: DSGE modeling
  - Operations: fine-tune QE and policy rate
  - Supervision: balance-sheet stats
- Regulation and Operations
  - Operations + Supervision: role of frictions
  - Frictions: key for transmission

> Background

New Keynesian Model:

- articulates: interest-rate + inflation tax channels

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  - environment w/o financial frictions

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- many rates moved by central banks

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Policy in Practice

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- banks trade reserves, face frictions
- implementation: M eases frictions and moves spreads

> Many Questions...

- When does CB balance sheet size matter?
    - when does it stimulate credit?
    - when does it translate into price level?

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- When does CB balance sheet size matter?
  - when does it stimulate credit?
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- When does CB balance sheet composition matter?
  - Are all QE instruments equal?
  - can CBs target sectors | regions of the economy?

> Goal

- Leading framework: new-Keynesian
  - irrelevant for these questions
  - QE works: only through forward-guidance on fiscal considerations (Caramp-Silva '21)

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- **Goal:** Simple framework
  - comparative statics analysis
  - encompasses multiple channels
  - bank frictions and market segmentation

> Contribution

- Identify **key elasticities**
  - elasticities: associated with different channels
  - elasticities: identifies sources of neutrality
  - elasticities: measure strength of channels
- Empirical goal (not today)
  - estimate elasticities
  - quantify effects through different channels
    - use theory

Baseline Framework

* Baseline

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* Baseline

> Notation

* R real rates

> Notation

- R real rates
- i nominal rates
- *All* individual variables are real
- all aggregate quantities real...except for M

> Non Banking: Asset Demand System

* critical: segmentation

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Demand System

Deposit supply:

$$D = \left(R^{D}_{t+1}\right)^{\epsilon^{D}}$$

Loan demand:

$$L = \left(R^{\ell}_{t+1}\right)^{\epsilon^{\ell}}$$

> Central Bank

* Standard Instrument :

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

* Second Instrument (quantity of reserves):

$$M$$

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- Classic exercise:

$$P \cdot T + \text{Discount Window Loans} = M(1+i^m) - M'$$

  - T transfers (a.k.a. printing press, helicopter drops, or “maquinita”)

> Bank's Probℓem | No Frictions

* Bank maximizes:

$$\max_{\{\ell, m, d, Div\} \geq 0} Div + \beta \underbrace{R^{\ell}\ell + R^{m}m - R^{d}d}_{\{\text{Expected Portfolio Returns}\}}$$

budget:

$$Div + \ell + m = n + d$$

> Bank's Problem w|o Frictions

* No frictions no arbitrage

Return Parity

$$\frac{1}{\beta} = R^{\ell} = R^{m} = R^{d}.$$

* Portfolio Return now:

$$\underbrace{R^{\ell}\ell + R^{m}m - R^{d}d}_{\text{Expected Portfolio Returns}} + \underbrace{\mathbb{E}\left[\chi(s|\theta)\right]}_{\text{Expected Settlement Costs}}$$

> Bank's Problem | Settlement Frictions

- Portfolio Return now:

$$\underbrace{R^{\ell}\ell + R^{m}m - R^{d}d}_{\text{Expected Portfolio Returns}} + \underbrace{\mathbb{E}\left[\chi(s|\theta)\right]}_{\text{Expected Settlement Costs}}$$

- Balance at central bank:

$$s = m - \delta d$$

or

$$s = m$$

  - χ: liquidity risk

> χ encodes interbank market

* χ capture settlement costs:

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

> Consequences

* Rates now depend on liquidity service and risk:

$$R^{\ell} = R^{m} + \frac{1}{2}\underbrace{\left[\chi^{+} + \chi^{-}\right]}_{\text{liqudity service}\mathcal{L}} = R^{d} - \frac{\delta}{2}\underbrace{\chi^{-}}_{\text{liquidity risk}}$$

Liquidity Premia

$$\frac{1}{\beta} = R^{\ell} > R^{d} > R^{m}.$$

> Consequences...

- Inelastic loan rate:

$$\frac{1}{\beta} = R^{\ell}$$

- Fixed liquidity premium
  - If R^m fixed by fixing i^m and future inflation...

$$\frac{1}{\beta} - R^m = \mathcal{L}$$

Neutrality

One time "helicopter drop"

$$\uparrow M = m(\mathcal{L}) \cdot \uparrow P$$

Constant Real Deposits:

$$D = d(\mathcal{L})$$

> In General - Equilibrium System

- Fully characterize equilibrium
- Static System of N equations, N unknowns
- System expressed in terms of local elasticities
- **flexible and easily scalable**

> Quantitative Easing (QE)

- Differential form of the central bank's budget constraint

$$\mathtt{d}L^g = \mathtt{d}M + \underbrace{\mathtt{d}\left[Pe^g(P) + T_0^b + T_0^{nb}\right]}_{\text{Revaluation effects}}$$

- Consider
  - nominal transfers
  - nominal assets/liabilities
- Then, we study

$$\mathtt{d}L^g = \mathtt{d}M$$

> Remarks

* $\frac{dP}{P}$ not expected inflation:

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

* Is counterfactual price change or (surprise inflation)

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

> Key Elasticities

- Key elasticities:
  1. $\frac{1}{\psi}$ internal equity elasticity
  2. ϵ^{d} external funding elasticity
  3. $\epsilon^{\ell}_{\bar{R}^{\ell}}$ and ϵ^{ℓ}_{P}, loan demand elasticities w.r.t. (expected) interest rate and price level
  4. $\mathcal{L}^{m}\epsilon^{\mathcal{L}^{m}}_{\theta}$ and $\mathcal{L}^{d}\epsilon^{\mathcal{L}^{d}}_{\theta}$ (semi) elasticities of liquidity premia w.r.t. market tightness
  5. Consolidated equity (of central bank and private banks) exposure to price level:

$$\epsilon^{e}_{P} = \frac{e'(P)}{e(P)}\frac{P}{dP}.$$

- Key Financial ratios:

$$\omega_e = \frac{1}{div/e^b(P)}, \quad \omega_\ell = -\frac{\ell^b/e^b(P)}{div/e^b(P)}, \quad \omega_d = \frac{d/e^b(P)}{div/e^b(P)}$$

> Summary of effects over aggregate credit

Effects over aggregate credit

		Nominal Rigidity			
		None	Consolidated equity	Central bank equity	Sticky wages
Financial Friction	None	**N**	**N**	**N**	**N**
	Settlement friction	**N**	**Y**	**N**	**Y**
	Risk absorption	**N**	**Y**	**N**	**N**
	Both	**N**	**Y**	**Y**	**Y**

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General expression

$$\frac{\mathrm{d}\ell}{\ell} = \frac{1}{Den}\Big\{\left(\omega_e\epsilon^e_P + \omega_{\tau_h}\right)\left(R^f R^d \mathcal{L}^m \epsilon_\theta^{\mathcal{L}^m} + \varphi\gamma\mathbb{V}\left(R^\ell\right)\epsilon^\ell_{\bar{R}^\ell} R^f m\Omega\right) + \epsilon^\ell_P \mu\left(R^d\epsilon^d\omega_d\left(\mathcal{L}^m\epsilon_\theta^{\mathcal{L}^m} + \mathcal{L}^d\epsilon_\theta^{\mathcal{L}^d}\right)\right)\ldots$$

$$\ldots - \left(e^g(P) - \frac{T^b_0 + T^h_0}{P}\right)\varphi\gamma\mathbb{V}\left(R^\ell\right)\epsilon^\ell_{\bar{R}^\ell}\left(R^d\mathcal{L}^m\epsilon_\theta^{\mathcal{L}^m}\psi + R^f\epsilon^d\omega_d\left(\mathcal{L}^m\epsilon_\theta^{\mathcal{L}^m} + \mathcal{L}^d\epsilon_\theta^{\mathcal{L}^d}\right)\right)\Big\}\frac{\mathrm{d}M}{M}$$

> Remarks

* Differential system captures essential elements of the theory
* Connect w/ number of results
  * Modigliani-Miller Theory
  * Fisherian-Debt Deflation
  * Liquidity Trap
  * Loan market segmentation

> Discussion: What about inflation today?

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- 2009-2015 Inflation: very mild!
- 2020-2022 Inflation: very high!
- Can QE be partially responsible?
  - QE on different assets
  - stronger financial sector - funding elasticity
  - stronger credit sector - loan elasticity
  - smoking gun: nominal deposit growth

Directed Monetary Policy

> Neutrality under heterogeneity

- When does composition of balance sheet matter?
- Multiple dimensions of heterogeneity
  - bank specific
    - funding elasticity
    - liquidity exposure
  - sectoral loan/deposit demand
    - elasticities
    - cross-bank elasticities
- These dimensions do not matter
  - as long as assets have similar liquidity/risk properties
  - interbank market is integrated

> Bank's Problem | Government Bonds

* Portfolio Return with government bond:

$$\underbrace{R^{\ell}\ell + R^{b}b + R^{T}b^{T} + + R^{m}m - R^{d}d}_{\text{Expected Portfolio Returns}} + \mathbb{E}\left[\chi(s|\theta)\right]$$

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- Settlement balance:

$$s = m + b - \delta d$$

> Short-term Rate Puzzle

* We now have:

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$$R^\ell = \underbrace{R^T > R^b > R^m}.$$

- CB: can move yield curve!
  - no interest-rate risk
  - liquidity premium!

> Bank's Problem | Sectoral Bonds

* Sectors i and j:

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- Bank specific effects (e.g. LTRO)?
  - could have bank specific loan-demand curves (does not matter)

Small Semi–Open Economies

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  - what are the effects of reserve accumulation
  - why are internventions sterilized
  - of reserve requiremetns in different currency

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* Impossible Trinity
  * how did Peru control inflation and FX for decades?

> Central Bank

- Now allow: M, F^*, T

$$T + \frac{M'}{P} + \text{Discount Window} + R^{\ell} L^{g} + R^{m} F^{*} \frac{e}{P} = R^{m} \frac{M}{P} + F^{*\prime} \frac{e}{P} + L^{g\prime}$$

  - L^{g} are private loans held by the central bank
  - F^{*} reserves

> Central Bank

- Bank maximizes:

$$\max_{\{b,m^*,d^*,d,m\}\geq 0} \quad Div + \quad \beta\left[R^{\ell}\cdot\ell + R^{m}m - R^{d}d + \mathbb{E}\left[\chi\left(m,d\right)\right]\right]$$

$$+ \quad \beta\left[\underbrace{\left\{R^{m,*}m^* - R^{*,d}d^*\right\}}_{\text{Dollar Portfolio Returns}} + \mathbb{E}\left[\chi^*\left(m^*,d^*\right)\right]\right]$$

w/ budget

$$Div + \ell + m^* + m = n + d + d^*$$

- Dollar balances:

$$s^* = m^* - \rho^* d^* + \delta^* d^*$$

or

$$s^* = m^* - \rho^* d^*$$

> Carry Trade and Local Optimization

- Foreign investors attracted by interest-rate differential:

$$\frac{M^*_{t+1}}{M^*_t} = \epsilon^f \left(R^d - R^{m,*} \right)$$

  but capital moves slowly.

- Optimization of savings:

$$R^d \approx R^{d*}$$

> Forex

So long as capital not perfectly mobile:

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* not capital controls, just mobility

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Forex and Sterilization

1) Dollar purchases:

$$\uparrow F^* \rightarrow \uparrow e$$

2) There's a bond purchase such that:

$$\uparrow F^*, \uparrow L^g \rightarrow \uparrow e, \bar{P}$$

Dollarization

- Dollarization does not impair MP
- But has costs...
  - current account deficit:

$$R^{d*} > R^{m*}$$

    discount window

> Reserve Requirements

- Introduction of capital requirments
  - appreciates dollar
  - increase liquidity ratio in dollars

Forex and Sterilization

- Increase in ρ^*:

$$\uparrow \rho^* \rightarrow \uparrow e, \uparrow \mu^*, \downarrow D^*$$

Extensions

> Other Considerations

- Approach is **flexible and scalable**
  - flexible to accommodate other mechanisms
  - scalable to more granular information

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- incorporating other mechanisms and information
  - regulation
  - risk absorption
  - heterogeneity: asset markets, geography, institutions

Other Mechanisms: Regulation and Risk

* **Regulation**
* **Risk**

Other Mechanisms: Regulation and Risk

* Regulation
* Risk

> Other Mechanism | Capital Requirements

* Assume there are capital requirements:

$$d \leq \kappa e^{b}(P)$$

* Modifies funding elasticity:

$$\frac{\mathrm{d}d}{d} = \kappa \epsilon_P^e \frac{\mathrm{d}P}{P}$$

QE Effects

$$\begin{bmatrix} \frac{\mathrm{d}P}{P} \\ \\ \frac{\mathrm{d}\ell}{\ell} \end{bmatrix} = \mathcal{A}^{-1} \begin{bmatrix} 1 \\ \\ 0 \end{bmatrix} \frac{\mathrm{d}M}{M}.$$

where

$$\mathcal{A} \equiv \begin{bmatrix} \left(1 - \frac{1}{\psi}\omega_d \kappa\right)\epsilon_P^e & \frac{1}{\epsilon_\ell}\frac{R^\ell}{\mathcal{L}^m}\frac{1}{\epsilon_\theta^{\mathcal{L}^m}(1+\theta^{-1})} \\ \\ -\frac{1}{\psi}\left(\omega_e + \omega_d \kappa\right)\epsilon_P^e & \frac{1}{\epsilon_\ell} + \frac{1}{\psi}\omega_\ell \end{bmatrix}.$$

> Other ECB considerations

- Risky Absorption
  - QE: again neutral if internal funding frictionless
  - Risk-absorption? bank must be specifically exposed to non diversified risk

Other Mechanisms: Regulation and Risk

* **Regulation**
* **Risk**

* Add risk and risk-weights:

$$v(n) = \max_{\{b,m,d,n\}\geq 0} Div + \beta \mathbb{E}\left[\Lambda(X) \cdot v(n')\right]$$

* Again, nothing changes:

$$\frac{1}{\beta} = \mathbb{E}\left[\Lambda\left(X\right)R^{b}\left(X\right)\right]$$

> Policy | Risk-Absorption

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- Similar logic

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- Similar logic
- No direct effects
  - possible: forward guidance

> Policy | Different Bank Equity Segmented?

- Yes: risk absorption can impact risk weights

$$\ell \leq \kappa\,(\text{risk})\,n$$

- or bank "risk aversion"

$$\mathbb{CE}\,[]$$

- Modifies:

$$R^{\ell} - R^{x} = \mathit{same} + \underbrace{\Gamma}_{\text{risk premium}}$$

- Takeaway: need bank segmentation again
  - Silva's JMP

Geographical Heterogeneity

> "Geographical" differences

- Bank j: differs in access to loan markets, preferences, etc.
- Geography i: physical location, industrial sector, consumer vs. firm, etc.
- ℓ^{ij} such that:

$$\ell^i = \sum_{j \in \mathcal{J}} \ell^{ij}$$

- example:
  - same interbank market, inelastic deposits

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QE Effects

Consider QE $\mathtt{d}M = \mathtt{d}L^g$ when $d = \kappa$. Then:

$$\begin{bmatrix} \frac{\mathtt{d}P}{P} \\ \\ \frac{\mathtt{d}\ell^{ij}}{\ell} \end{bmatrix} = \mathcal{A}^{-1} \begin{bmatrix} 1 \\ \\ 0 \end{bmatrix} \frac{\mathtt{d}M}{M}.$$

for suitable $\mathcal{A}$

$$\frac{d\ell^i}{\ell} = \Omega^{ij} \frac{\mathtt{d}\ell^{ij}}{\ell}$$

Asset Liquidity Heterogeneity

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- Settlement balance:

$$s = m + b - \delta d$$

- Tightness (interbank market conditions)

$$\theta = -\frac{\overbrace{m - \delta d}^{\text{deficit}}}{\underbrace{m - b}_{\text{surplus}}}$$

> Affecting - Liquidity Component of Yields

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  - interest-rate risk: deficit
  - liquidity premium!

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- End goal
  - estimate key-elasticities
  - build a tool to evaluate central bank QE

Extension: Price-Level Target

> Variation

- We kept price level constant
- Redo with inflation target:
  - similar lessons

Example

Version with Inflation Target

$$\frac{d\ell^b}{\ell^b} = -\frac{\left(1-\zeta^b\right) - \epsilon^B \epsilon_m^{\mathcal{L}^d}}{\epsilon^B \epsilon_d^{\mathcal{L}^m} - \zeta^b} \frac{d\ell^g}{\ell^g}$$

and

$$\frac{d\,[d]}{d} = \frac{\left(1-\zeta^b\right) - \epsilon^B \epsilon_{\ell g}^{\mathcal{L}^m}}{\epsilon^B \epsilon_d^{\mathcal{L}^m} - \zeta^b} \frac{d\ell^g}{\ell^g}.$$