3.36pt

Banks, Liquidity Management and Monetary Policy

Javier Bianchi   Saki Bigio

Minneapolis Fed & NBER   UCLA &NBER

Motivation

- Financial crisis raised unprecedented challenges for central banks:

  - Worst recession since Great Depression

  - Persistently low inflation

- Despite aggressive monetary policy

  - Weak economic recovery

  - Depressed bank lending

Motivation

- Financial crisis raised unprecedented challenges for central banks:

  - Worst recession since Great Depression

  - Persistently low inflation

- Despite aggressive monetary policy

  - Weak economic recovery

  - Depressed bank lending

- Center of debate: banks' reaction to monetary stimulus

  - Why are banks not lending?

- Unfortunate divorce between Money and Banking
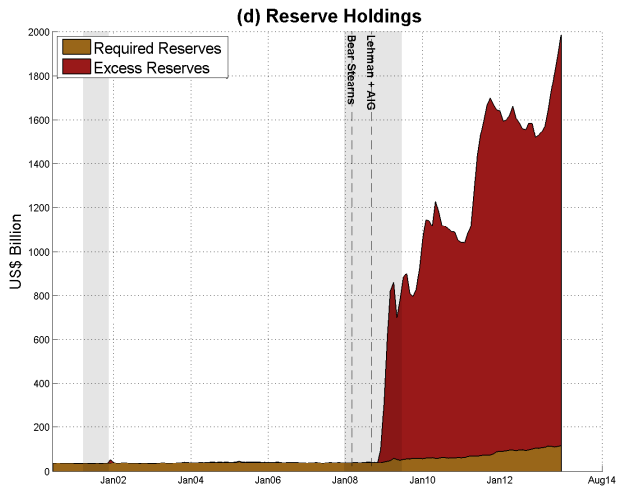
Bank Lending
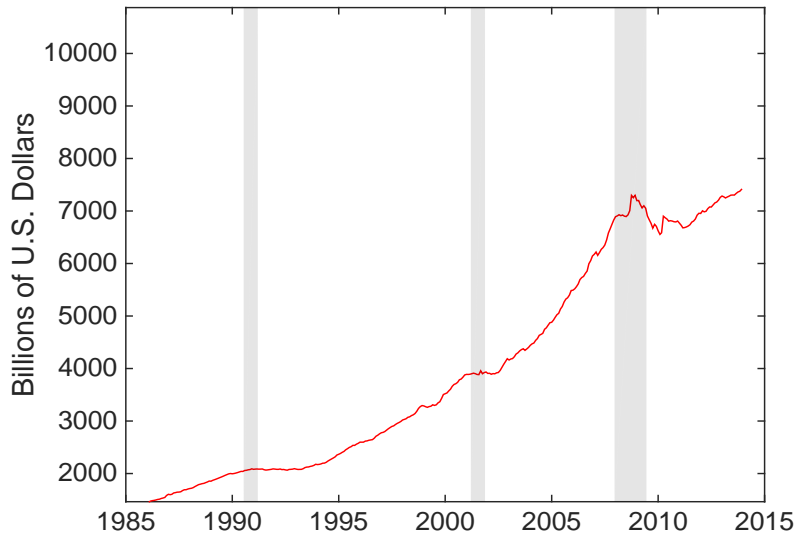
Bank Lending and Deposits
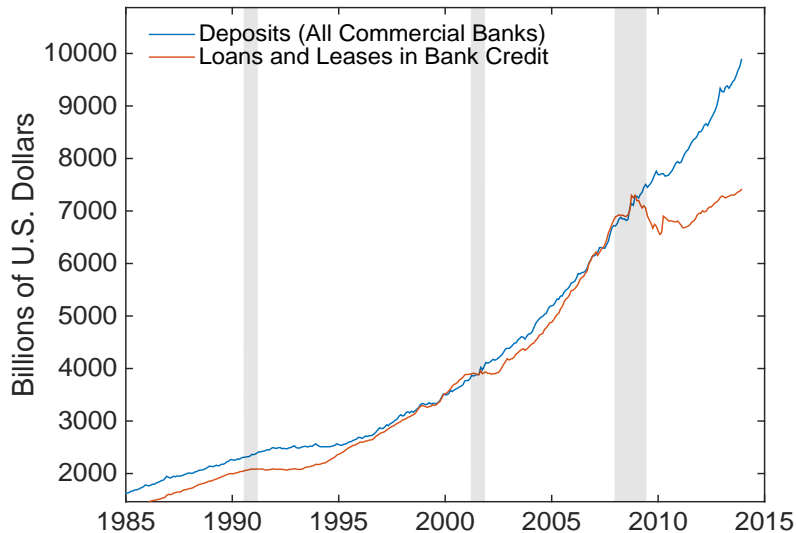
Excess Reserves

(d) Reserve Holdings

★ A micro-founded dynamic quantitative model of banks' liquidity management and monetary policy

This Paper

★ A micro-founded dynamic quantitative model of banks' liquidity management and monetary policy

- Classic Liquidity Management
  - (+) Profit on Loans
    - Spread between loans and deposits
  - (-) Illiquidity Risk
    - After deposits transfers, bank may be short of reserves/liquid assets

This Paper

★ A micro-founded dynamic quantitative model of banks' liquidity management and monetary policy

- Classic Liquidity Management
  - (+) Profit on Loans
    - Spread between loans and deposits
  - (-) Illiquidity Risk
    - After deposits transfers, bank may be short of reserves/liquid assets

★ GE model with endogenous liquidity premium & money multiplier

This Paper _____

★ A micro-founded dynamic quantitative model of banks' liquidity management and monetary policy

- Classic Liquidity Management
  - (+) Profit on Loans
    - Spread between loans and deposits
  - (-) Illiquidity Risk
    - After deposits transfers, bank may be short of reserves/liquid assets

★ GE model with endogenous liquidity premium & money multiplier

★ Credit channel of monetary policy

Model Overview

1. Bank individual decision problem:

   - Loan issuances, liquid assets, deposit creation, retain earnings
   - Subject to capital requirements, liquidity requirements
   - ★ Demand for excess reserves

Model Overview

1. Bank individual decision problem:
   - Loan issuances, liquid assets, deposit creation, retain earnings
   - Subject to capital requirements, liquidity requirements
   - ★ Demand for excess reserves

2. Bank industry dynamics:
   - Return on loans, interbank-market rate, price level determined in equilibrium
   - Stochastic steady state and transitional dynamics

Model Overview

1. Bank individual decision problem:
   - Loan issuances, liquid assets, deposit creation, retain earnings
   - Subject to capital requirements, liquidity requirements
   - ★ Demand for excess reserves

2. Bank industry dynamics:
   - Return on loans, interbank-market rate, price level determined in equilibrium
   - Stochastic steady state and transitional dynamics

3. Laboratory for policy analysis: changes in reserve requirements, IOER, capital requirements, discount window rates, conventional/unconventional policies

Model Overview _____

1. Bank individual decision problem:
   - Loan issuances, liquid assets, deposit creation, retain earnings
   - Subject to capital requirements, liquidity requirements
   - ★ Demand for excess reserves

2. Bank industry dynamics:
   - Return on loans, interbank-market rate, price level determined in equilibrium
   - Stochastic steady state and transitional dynamics

3. Laboratory for policy analysis: changes in reserve requirements, IOER, capital requirements, discount window rates, conventional/unconventional policies

★ Tractability

- Why are banks not lending and "stockpiling" liquid assets?

- Why are banks not lending and "stockpiling" liquid assets?

- Five Hypothesis
    1. Equity Losses (Stiglitz)

Application _____

- Why are banks not lending and "stockpiling" liquid assets?

- Five Hypothesis
    1. Equity Losses (Stiglitz)

    2. Capital Requirements (Krishnamurthy, Suarez)

- Why are banks not lending and "stockpiling" liquid assets?

- Five Hypothesis

    1. Equity Losses (Stiglitz)

    2. Capital Requirements (Krishnamurthy, Suarez)

    3. Precautionary Holdings (Lucas, Gorton)

Application _____

- Why are banks not lending and "stockpiling" liquid assets?

- Five Hypothesis

  1. Equity Losses (Stiglitz)

  2. Capital Requirements (Krishnamurthy, Suarez)

  3. Precautionary Holdings (Lucas, Gorton)

  4. Weak Loan Demand (Cochrane, Sims)

Application _____

- Why are banks not lending and "stockpiling" liquid assets?

- Five Hypothesis
    1. Equity Losses (Stiglitz)

    2. Capital Requirements (Krishnamurthy, Suarez)

    3. Precautionary Holdings (Lucas, Gorton)

    4. Weak Loan Demand (Cochrane, Sims)

    5. Interest on Excess Reserves (Feldstein, Hall)

Literature Review _____

- **Reserve Management:** Poole (JF,1968),Bolton et al. (2012), Saunders et al. (2011), Afonso & Lagos (2015)

- **Classic models of Banking:** Diamond & Dybvig (1983), Allen & Gale (1998), Holmstrom & Tirole (1997,1998)

- **Banking in Macro:** Gertler & Karadi(2009), Gertler & Kiyotaki (2011,2012), Curdia & Woodford(2009), Corbae & D'erasmo (2013,2014)

- **Payments:** Freeman(AER,1996), Cavalcanti et al. (1998), Piazzesi and Schneider (2015)

- **Money & credit:** , Wright et al. (2014), Brunnermeier & Sannikov (2013), Williamson (2012,2016), Kiyotaki & Moore (2012)

- **Excess Reserves:** Armenter & Lester (2015), Ennis (2014)

Literature Review

- **Reserve Management:** Poole (JF,1968),Bolton et al. (2012), Saunders et al. (2011), Afonso & Lagos (2015)

- **Classic models of Banking:** Diamond & Dybvig (1983), Allen & Gale (1998), Holmstrom & Tirole (1997,1998)

- **Banking in Macro:** Gertler & Karadi(2009), Gertler & Kiyotaki (2011,2012), Curdia & Woodford(2009), Corbae & D'erasmo (2013,2014)

- **Payments:** Freeman(AER,1996), Cavalcanti et al. (1998), Piazzesi and Schneider (2015)

- **Money & credit:** , Wright et al. (2014), Brunnermeier & Sannikov (2013), Williamson (2012,2016), Kiyotaki & Moore (2012)

- **Excess Reserves:** Armenter & Lester (2015), Ennis (2014)

- **Time:** t=1,2,3,....

- **Time:** t=1,2,3,....
    - **Two stages:** s=l,b
    - Lending stage (l) and balancing stage (b)

- **Time:** t=1,2,3,....
  - **Two stages:** s=l,b
  - Lending stage (l) and balancing stage (b)

- Continuum of banks with idiosyncratic liquidity shocks

- **Time:** t=1,2,3,....

  - **Two stages:** s=l,b

  - Lending stage (l) and balancing stage (b)

- Continuum of banks with idiosyncratic liquidity shocks

- **Utility function:** Concave utility U over dividends c_t, $u(c) = \frac{c^{1-\sigma}}{1-\sigma}$

Banks' Balance Sheet _____

- Liabilities:
  - d_t demand deposits
- Assets:
  - m_t liquid assets (central bank reserves, T-bills)
  - b_t loans
- Interbank market loans f_t and discount-window loans w_t
- All assets/liabilities denominated in nominal terms

Banks' Problem (Lending Stage)─────────────

- Budget constraint

$$P_t c_t^j + \tilde{b}_{t+1}^j + \tilde{m}_{t+1}^j - \tilde{d}_{t+1}^j = b_t^j(1 + i_t^b) + m_t^j(1 + i_t^{ior}) - d_t^j(1 + i_t^d) -$$
$$\left(1 + \bar{\imath}_t^f\right) f_t^j - \left(1 + i_t^{dw}\right) w_t^j - P_t T_t$$

- P_t price of goods in terms of reserves

Banks' Problem (Lending Stage) ⎯⎯⎯⎯⎯⎯⎯⎯⎯

- Budget constraint

$$P_t c_t^j + \tilde{b}_{t+1}^j + \tilde{m}_{t+1}^j - \tilde{d}_{t+1}^j = b_t^j(1 + i_t^b) + m_t^j(1 + i_t^{ior}) - d_t^j(1 + i_t^d) -$$
$$\left(1 + \bar{\imath}_t^f\right) f_t^j - \left(1 + i_t^{dw}\right) w_t^j - P_t T_t$$

- P_t price of goods in terms of reserves

- Capital requirement constraint

$$\tilde{d}^j \leq \kappa \left(\tilde{b}^j + \tilde{m}^j - \tilde{d}^j\right) \tag{1}$$

Banks' Problem (Balancing Stage)————————

- Idiosyncratic withdrawal shock $\omega \in (-1, \infty], \omega \sim F_t(\omega), \quad \mathbb{E}(\omega) = 0$
- Borrow in interbank market f to satisfy res. req. (or $m_{t+1} \geq 0$)

$$d_{t+1}^j = \tilde{d}_{t+1}^j + \omega_t \tilde{d}_{t+1}^j$$

$$m_{t+1}^j = \tilde{m}_{t+1}^j + \omega_t^j \tilde{d}_{t+1}^j \left(\frac{1 + i_{t+1}^d}{1 + i_{t+1}^{ior}}\right) + f_{t+1}^j + w_{t+1}^j,$$

$$m_{t+1}^j \geq \rho d_{t+1}^j$$

$$s^j \equiv \underbrace{\tilde{m}_{t+1}^j - \omega \tilde{d}_{t+1}^j}_{\text{Reserves left}} - \underbrace{\rho \tilde{d}_{t+1}^j (1 - \omega)}_{\text{Deposits left}}$$

Banks' Problem (Balancing Stage)

- Idiosyncratic withdrawal shock $\omega \in (-1, \infty], \omega \sim F_t(\omega), \quad \mathbb{E}(\omega) = 0$
- Borrow in interbank market f to satisfy res. req. (or $m_{t+1} \geq 0$)

$$d_{t+1}^j = \tilde{d}_{t+1}^j + \omega_t \tilde{d}_{t+1}^j$$

$$m_{t+1}^j = \tilde{m}_{t+1}^j + \omega_t^j \tilde{d}_{t+1}^j \left(\frac{1 + i_{t+1}^d}{1 + i_{t+1}^{ior}} \right) + f_{t+1}^j + w_{t+1}^j,$$

$$m_{t+1}^j \geq \rho d_{t+1}^j$$

$$s^j \equiv \underbrace{\tilde{m}_{t+1}^j - \omega \tilde{d}_{t+1}^j}_{\text{Reserves left}} - \underbrace{\rho \tilde{d}_{t+1}^j (1 - \omega)}_{\text{Deposits left}}$$

Interbank Market

- "Dollar to dollar" matching (OTC markets of Atkeson et al. 2014)

- N rounds of matching

- Matching function for dollars in surplus (S^+) and deficit (S^-)

- Terminal outside options are discount window rates and interest on reserves

- Nash Bargaining

- See paper for analytical results for Fed funds rate and matching probabilities

- Wedge in return to excess reserves and reserves deficits:
- Marginal Benefit of excess reserves:

$$\chi_t^+ = \gamma^+ \bar{\imath}_t^f + (1 - \gamma^+) i^{ior}$$

- Marginal cost of reserve deficits:

$$\chi_t^- = \gamma^- \bar{\imath}_t^f + \left(1 - \gamma^-\right) i_t^{dw}.$$

- Liquidity Cost Function:

$$\chi(s) = \left\{ \begin{array}{ll} \chi_t^+ s & \text{if } s > 0 \\ \chi_t^- s & \text{if } s \leq 0 \end{array} \right.$$
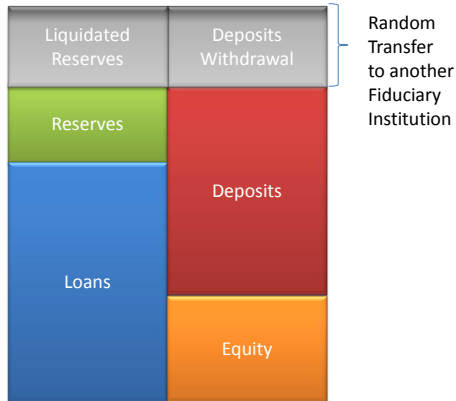
Expansion of Lending
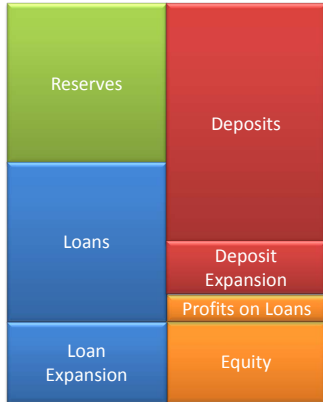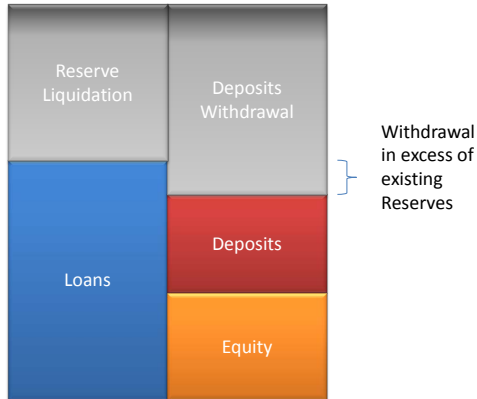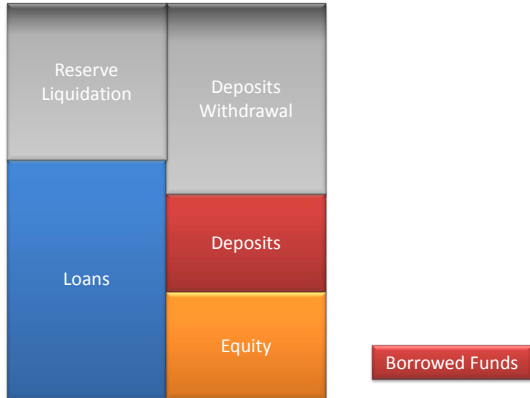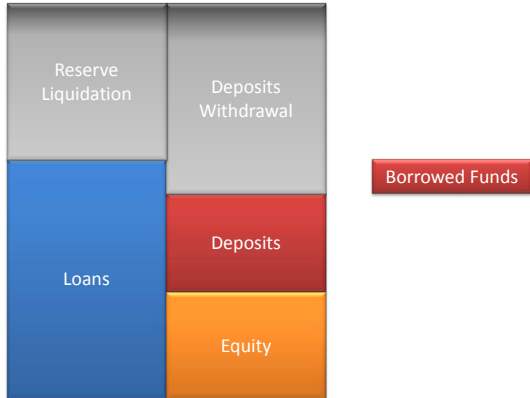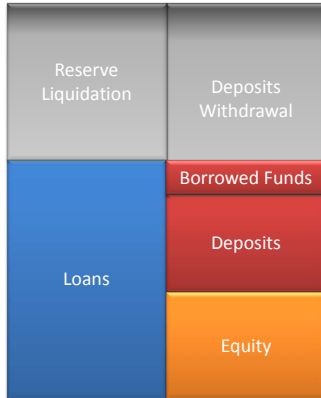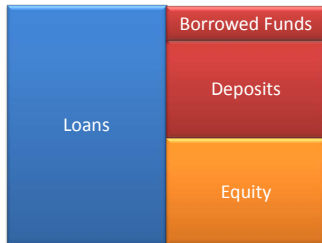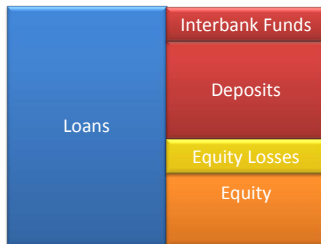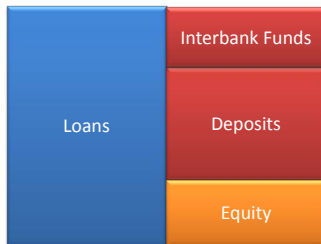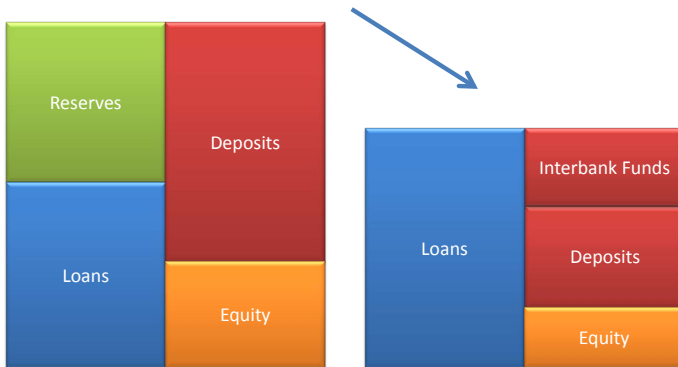
Value Function - Lending Stage _____

$$V_t^l\left(b, m, d, f, w\right) = \max_{\left\{c, \tilde{b}, \tilde{d}, \tilde{m}\right\} \geq 0} u\left(c\right) + \mathbb{E}\left[V_t^b(\tilde{b}, \tilde{m}, \tilde{d}, \omega)\right]$$

$$P_t c + \tilde{b} + \tilde{m} - \tilde{d}$$
$$= b(1 + i_t^b) - d(1 + i_t^d) + m(1 + i_t^{IOR}) - (1 + \bar{\imath}_t^f)f - \left(1 + i_t^{dw}\right)w - P_t T_t$$
$$\text{(Budget Constraint)}$$

$$\tilde{d} \leq \kappa\left(\tilde{b} + \tilde{m} - \tilde{d}\right). \qquad\qquad \text{(Capital Requirement)}$$

Value Function - Balancing Stage _____

$$V_t^b(\tilde{b}, \tilde{m}, \tilde{d}, \omega) = \beta V_t^l(b', \tilde{m}', d', f, w)$$

$$b' = \tilde{b} \qquad \text{(Evolution of Loans)}$$

$$d' = \tilde{d} + \omega\tilde{d} \qquad \text{(Evolution of Deposits)}$$

$$m' = \tilde{m} - \omega\tilde{d}\left(\frac{1 + i_{t+1}^d}{1 + i_{t+1}^{ior}}\right) + f + w$$
$$\text{(Evolution of Reserves)}$$

$$s = \tilde{m} + \frac{\omega_t \tilde{d}_{t+1}\left(1 + i_{t+1}^d\right)}{1 + i_{t+1}^{IOR}} - \rho\tilde{d}_{t+1}\left(1 + \omega\right)$$
$$\text{(Reserve Balance)}$$

$$m' \geq \rho d' \qquad \text{(Reserve Requirement)}$$

$$f = \psi_t^- s \text{ and } w_{t+1} = \left(1 - \psi_t^-\right) s \text{ for } s < 0 \qquad (2)$$
$$f = \psi_t^+ s \text{ and } w_{t+1} = 0 \text{ for } s > 0.$$

One Value Function

Define

$$e_t \equiv \frac{b_t(1+i_t^b) + m_t(1+i_t^{ior}) - d_t(1+i_t^d) - \left(1+i_t^f\right)f_t - \left(1+i_t^f\right)w_t - T_t}{P_t}.$$

$$V_t(e) = \max_{\{c,\tilde{m},\tilde{b},\tilde{d}\} \geq 0} u(c) + \beta \mathbb{E}_t\left[V_{t+1}(e')\right],$$

$$e = \frac{\tilde{b} + \tilde{m} - \tilde{d}}{P_t} + c, \qquad \text{(Budget Constraint)}$$

$$e' = \left((1+i_{t+1}^{ior})\tilde{m} + (1+i_{t+1}^b)\tilde{b} - (1+i_{t+1}^d)\tilde{d} + \chi_{t+1}(s)\right) \frac{(1-\tau_{t+1})}{P_{t+1}}, \qquad \text{(Evolution of Equity)}$$

$$s = \tilde{m} + \frac{\omega_t \tilde{d}'\left(1+i_{t+1}^d\right)}{1+i_{t+1}^{IOR}} - \rho \tilde{d}'\left(1+\omega\right) \qquad \text{(Reserve Balance)}$$

$$\tilde{d} \leq \kappa\left(\tilde{b} + \tilde{m} - \tilde{d}\right). \qquad \text{(Capital Requirement)}$$

Closing the Model ⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯

- Loan Market Clears

$$\frac{B_{t+1}^d}{P_t} = \Theta_t^b \left(\frac{1}{(1+i_{t+1}^b)} \frac{P_{t+1}}{P_t} \right)^\epsilon, \epsilon > 0, \Theta_t > 0,$$

- Deposit Market Clears (today perfectly elastic supply)

$$\frac{D_{t+1}^S}{P_t} = \Theta_t^d \left(\frac{1}{(1+i_{t+1}^d)} \frac{P_t}{P_{t+1}} \right)^\varsigma, \varsigma > 0, \Theta_t^d > 0,$$

Central Bank Policies: The Fed _____

- Sets quantity of reserves M_t^{Fed}

- Buys loans B_{t+1}^{FED}, place deposits D_{t+1}^{FED}

- Discount window and interest on reserve rates i^{dw}, i^{ior}

- Fed budget constraint:

$$M_t^{Fed}(1 + i_t^{ior}) + D_{t+1}^{Fed} + B_{t+1}^{Fed} + W_{t+1}^{Fed}...$$
$$= M_{t+1}^{Fed} + D_t^{Fed}(1 + i_t^d) + B_t^{Fed}(1 + i_t^b) + W_t^{Fed}(1 + i_t^{dw}) + P_t T_t.$$

- Stationary equilibrium: constant nominal growth of balance sheet

- Impulse responses: focus on fixed nominal balance sheet or keep constant inflation (today)

Central Bank Policies: The Fed

- Sets quantity of reserves M_t^{Fed}

- Buys loans B_{t+1}^{FED}, place deposits D_{t+1}^{FED}

- Discount window and interest on reserve rates i^{dw}, i^{ior}

- Fed budget constraint:

$$M_t^{Fed}(1 + i_t^{ior}) + D_{t+1}^{Fed} + B_{t+1}^{Fed} + W_{t+1}^{Fed}...$$

$$= \quad M_{t+1}^{Fed} + D_t^{Fed}(1 + i_t^d) + B_t^{Fed}(1 + i_t^b) + W_t^{Fed}(1 + i_t^{dw}) + P_t T_t.$$

- Stationary equilibrium: constant nominal growth of balance sheet

- Impulse responses: focus on fixed nominal balance sheet or keep constant inflation (today)

Market Clearing

$$\int_j b_{t+1}^j + B_{t+1}^{Fed} = B_{t+1}^d \qquad \text{(Loans markets clearing)}$$
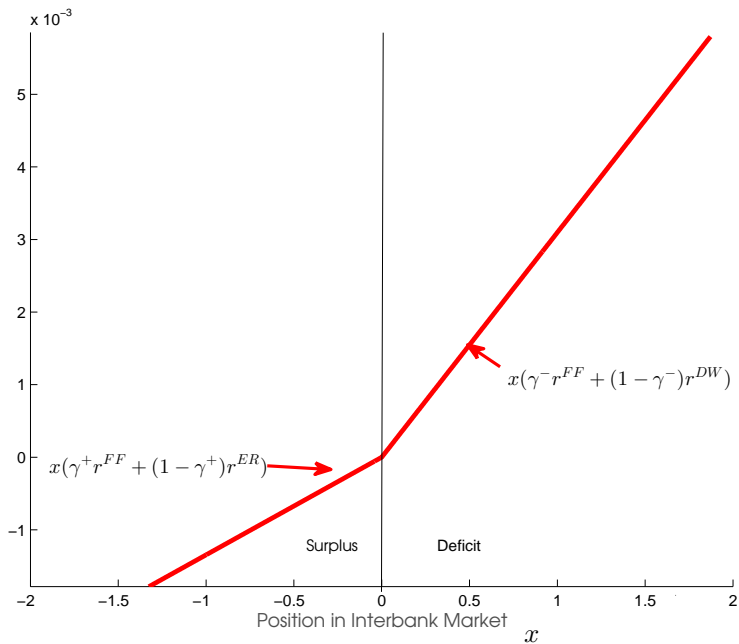
$$\int_j d_t^j - D_{t+1}^{Fed} = D_{t+1}^S \qquad \text{(Deposits market clearing)}$$

$$\int_j m_{t+1}^j = M_{t+1}^{Fed} \qquad \text{(Reserves market clearing)}$$

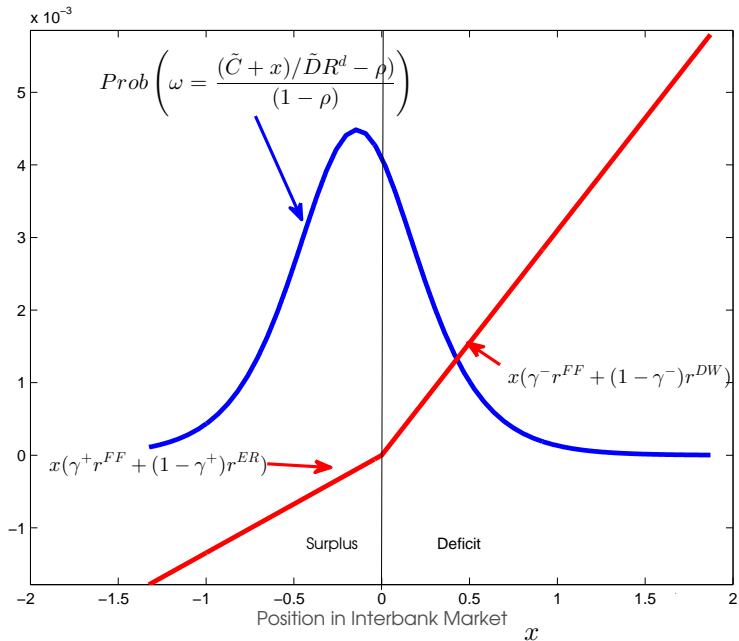$$\int_j f_t^j = 0 \qquad \text{(Interbank markets clearing)}$$

$$\int_j w_t^j = W_{t+1}^{Fed} \qquad \text{(Discount window market clearing)}$$

Liquidity Cost

$x \, 10^{-3}$

$$Prob\left(\omega = \frac{(\tilde{C}+x)/\tilde{D}R^d - \rho}{(1-\rho)}\right)$$

$x(\gamma^+ r^{FF} + (1-\gamma^+)r^{ER})$

$x(\gamma^- r^{FF} + (1-\gamma^-)r^{DW})$

Surplus   Deficit

Position in Interbank Market x

$$Prob\left(\omega = \frac{(\tilde{C}+x)/\tilde{D}R^d - \rho)}{(1-\rho)}\right)$$

$x(\gamma^- r^{FF} + (1-\gamma^-)r^{DW})$

$x(\gamma^+ r^{FF} + (1-\gamma^+)r^{ER})$

Surplus

Deficit

Position in Interbank Market x

$Prob\left(\omega = \dfrac{(\tilde{C} + x)/\tilde{D}R^d - \rho)}{(1 - \rho)}\right)$

$x(\gamma^- r^{FF} + (1 - \gamma^-)r^{DW})$

$x(\gamma^+ r^{FF} + (1 - \gamma^+)r^{ER})$

Surplus · Deficit

Position in Interbank Market · x
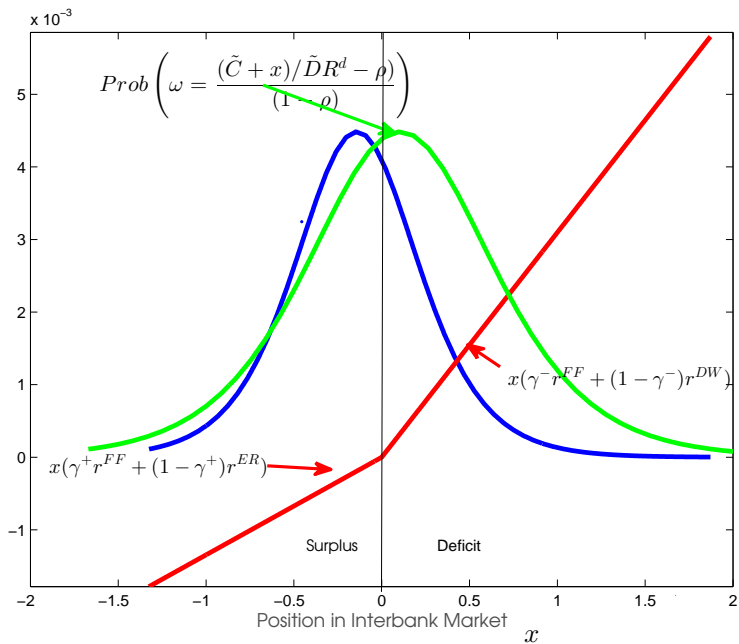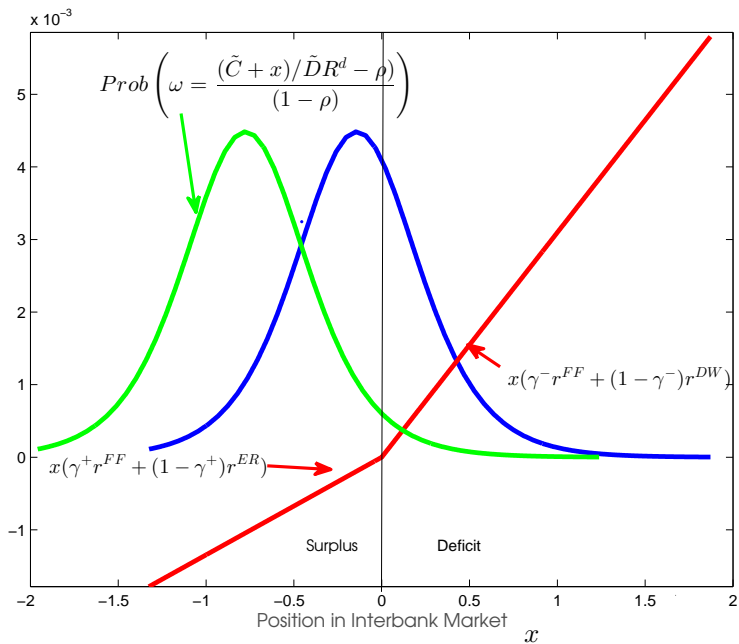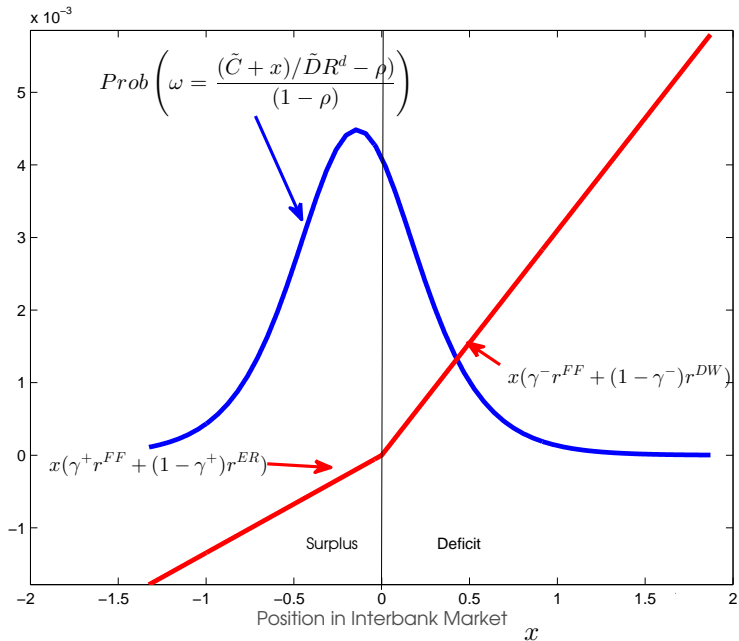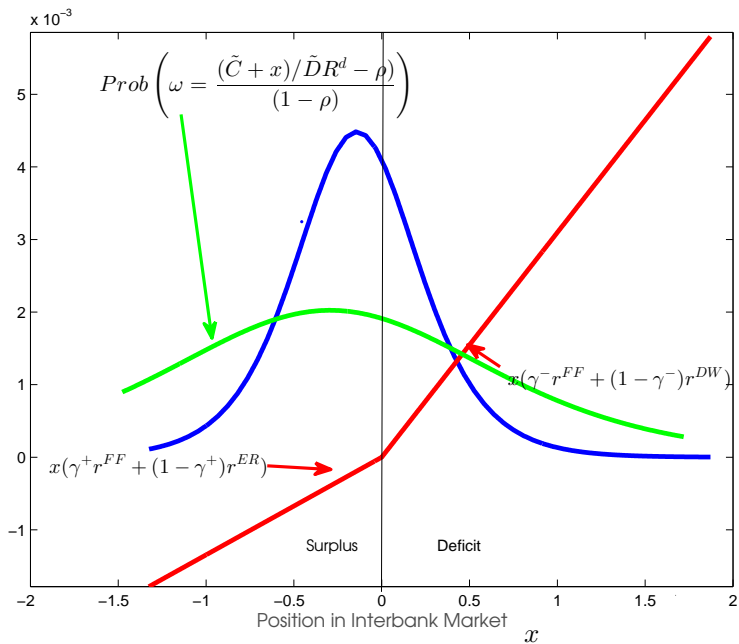
Equity Growth

Proposition (Homogeneity and Portfolio Separation)

(i) The value function $V_t(b, m, d)$ satisfies

$$V_t(e) = v_t(e)^{1-\gamma},$$

(ii) where $v(\cdot)$ satisfies
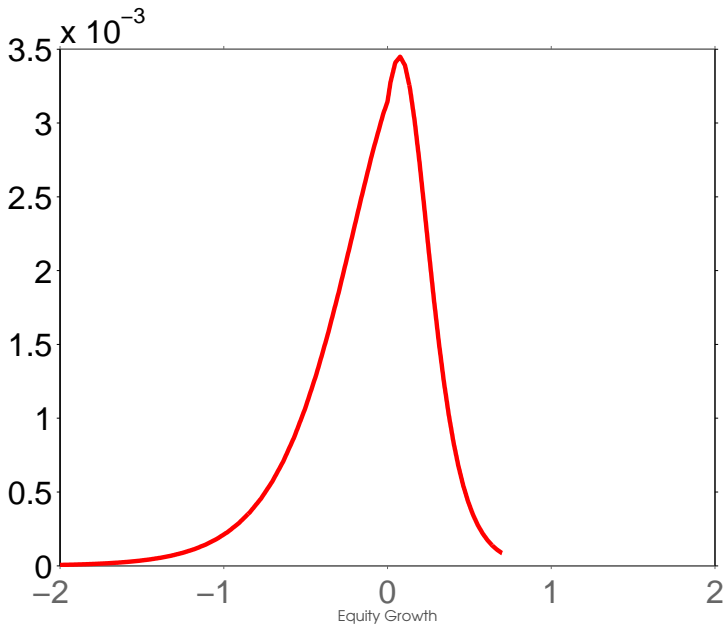
$$\Omega_t \equiv \max_{\{\bar{b}, \bar{m}, \bar{d}\} \geq 0} \left\{ \mathbb{E}_\omega \left[R_t^b \bar{b} + R_t^m \bar{m} - R_t^d \bar{d} + \chi(\bar{m}, \bar{d}, \omega) \right]^{1-\gamma} \right\}^{\frac{1}{1-\gamma}},$$

$$\bar{b} + \bar{m} - \bar{d} = 1,$$

$$\bar{d} \leq \kappa \left(\bar{b} + \bar{m} - \bar{d} \right).$$

(iii)

$$\begin{aligned}
\tilde{b}'_{t+1}(e_t) &= P_t \bar{b}_t (1 - \bar{c}) e_t, \\
\tilde{m}_{t+1}(e_t) &= P_t \bar{m}_t (1 - \bar{c}) e_t, \\
\tilde{d}_{t+1}(e_t) &= P_t \bar{d}_t (1 - \bar{c}) e_t.
\end{aligned}$$

(iv) $\bar{c}_t, v_t$ are given by

$$v_t = \frac{1}{1-\gamma} \left[1 + \left(\beta(1-\gamma)\Omega_t^{1-\gamma} v_{t+1} \right)^{\frac{1}{\gamma}} \right]^\gamma.$$

$$\bar{c}_t = \frac{1}{1 + [\beta(1-\gamma)v_{t+1}\Omega_t^{1-\gamma}]^{1/\gamma}}.$$

Liquidity Premium

$$\underbrace{R^b - R^m}_{\text{Liquidity Premium}} = \underbrace{\mathbb{E}_\omega \left[\frac{\partial \chi \left(\bar{d}, \bar{m}, \omega \right)}{\partial \bar{m}} \right]}_{\text{First-order liquidity premium}} + \underbrace{\mathbb{E}_\omega \frac{\mathbb{COV}_\omega \left[\left(R^e \right)^{-\gamma}, \frac{\partial \chi \left(\bar{d}, \bar{m}, \omega \right)}{\partial \bar{m}} \right]}{\mathbb{E}_\omega \left[\left(R^e \right)^{-\gamma} \right]}}_{\text{Liquidity risk premium}}$$

$$\underbrace{R^b - R^d}_{\text{External finance premium}} = \underbrace{\frac{\mathbb{E}_\omega \left[\left(R^e_\omega \right)^{-\gamma} \cdot \frac{\partial \chi \left(\bar{d}, \bar{m}, \omega \right)}{\partial \bar{d}} \right]}{\mathbb{E}_\omega \left[\left(R^e \right)^{-\gamma} \right]}}_{\text{Deposit Liquidity Cost}} + \underbrace{\frac{\mu}{\mathbb{E}_\omega \left[\left(R^e_\omega \right)^{-\gamma} \right]}}_{\text{Collateral term}}$$

Liquidity Premium

$$\underbrace{R^b - R^m}_{\text{Liquidity Premium}} = \underbrace{\mathbb{E}_\omega\left[\frac{\partial\chi\left(\bar{d},\bar{m},\omega\right)}{\partial\bar{m}}\right]}_{\text{First-order liquidity premium}} + \underbrace{\mathbb{E}_\omega\frac{\mathbb{COV}_\omega\left[\left(R^e\right)^{-\gamma}, \frac{\partial\chi\left(\bar{d},\bar{m},\omega\right)}{\partial\bar{m}}\right]}{\mathbb{E}_\omega\left[\left(R^e\right)^{-\gamma}\right]}}_{\text{Liquidity risk premium}}$$

$$\underbrace{R^b - R^d}_{\text{External finance premium}} = \underbrace{\frac{\mathbb{E}_\omega\left[\left(R^e_\omega\right)^{-\gamma} \cdot \frac{\partial\chi\left(\bar{d},\bar{m},\omega\right)}{\partial\bar{d}}\right]}{\mathbb{E}_\omega\left[\left(R^e\right)^{-\gamma}\right]}}_{\text{Deposit Liquidity Cost}} + \underbrace{\frac{\mu}{\mathbb{E}_\omega\left[\left(R^e_\omega\right)^{-\gamma}\right]}}_{\text{Collateral term}}$$

Banks are satiated with reserves if

(i) The Fed pays interest on reserves such that $i_t^{ior} = i_t^b$

(ii) The Fed pays interest on reserves such that $i_t^{ior} = i_t^D$, and $\kappa = \infty$

(iii) The Fed sets the discount window rate to $i_t^{dw} = 0$

Quantitative Exercise

Calibration Strategy _____

- F_t approximated with a logistic distribution
  - Cross-sectional distribution of deposits growth rates (Call Reports)
    - ▸ distribution

- Loan-demand elasticity = 1.8
  - Bassett, Chosak, Driscoll, and Zakrajsek (2013)

Calibration

	Value	Source/Target
Capital requirement	$\kappa = 10$	Regulatory parameter
Discount factor	$\beta = 0.993$	Dividend ratio = 8 %
Risk aversion	$\gamma = 1$	Constant dividend-equity ratio
Reserve requirement	$\rho = 0.1$	Regulatory parameter
Deposit supply intercept	$\Theta^d = 9.6$	Annual deposit rate = 1%
Loan demand intercept	$\Theta^b = 10.4$	Unit steady state equity
Discount window rate (annual)	$i^{dw} = 6\%$	2006 value
Interest on reserves (annual)	$i^{ior} = 0\%$	2006 value
Bargaining parameter	$\eta = 0.5$	Baseline value
Inflation	$g = 2\%$	Long-run inflation target
Matching friction	$\lambda = 2.1$	DW loans to reserves $W/M = 2$
Volatility	$\sigma = 0.04$	Reserve-balance distribution
Loan demand deposit supply elasticities	$\zeta = -\epsilon = 25$	Bank credit response to policy

- Why are banks not lending when holding so many reserves?

Quantitative Application _____

- Why are banks not lending when holding so many reserves?

- Five Hypotheses:
    1. Equity Losses
    2. Tighter Capital Requirements
    3. Precautionary Motive (Interbank Market Shutdown)
    4. Weaker Loan Demand
    5. Interest on Reserves

Quantitative Application ⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯

- Why are banks not lending when holding so many reserves?

- Five Hypotheses:
  1. Equity Losses
  2. Tighter Capital Requirements
  3. Precautionary Motive (Interbank Market Shutdown)
  4. Weaker Loan Demand
  5. Interest on Reserves

- *Approach*
  - First: Transitional Dynamics after individual shocks
  - Second: Fit calibrated sequences of shocks