Financial Regulation in a Quantitative Model of the Modern Banking System

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Motivation

▶ Financial System: regulated & unregulated banks
  ▶ provide access to “intermediated” assets, e.g. long term credit
  ▶ funded with liquidity services providing debt
  ▶ both bank types compete with each other

▶ Effects of financial regulation on a subset of banks?
  ▶ Does tighter regulation cause a shift to shadow banks?
  ▶ Does this make the financial system riskier?

▶ Answers depend on determinants of the relative bank type size in equilibrium and banks’ leverage choice

▶ Requires quantitative general equilibrium analysis
▶ Study effect of capital requirements
Model Overview

Intermediaries

Commercial Banks
Capital
Deposits
Equity

Shadow banks
Capital
Deposits
Equity

Capital produced by banks

Deposit Insurance

Households

Y Asset
(not intermediated)

Own Funds

Y Asset
C. Deposits
S. Debt
C. Equity
S. Equity

Deposits
(withdrawn early & bailout probability)

Capital

Equity

Equity

Commercial Banks

Shadow banks
Mechanism behind effects of tighter capital requirement

- Liquidity demand for shadow (S-) & com. (C-) bank debt
- S- and C-banks compete in liquidity provision
- Deposit insurance gives C-banks a comp. advantage

Two key equilibrium forces determine rel. size & leverage

1. HH’s liquidity demand implies that S-bank deposit rates fall when C-bank deposits fall - GE effect (*demand effect*)
2. Endog. allocation of S- and C-bank equity (*competition effect*)
Effect of $\uparrow \theta$ (cap req) when C-bank leverage determined by $D^C/E^C = \theta$

1. **Demand effect:** Lower $D^C$ reduces $r^S$ and increases $D^S$  
   $\Rightarrow$ Fixing $E^S$, higher S-bank leverage $D^S/E^S$ & S-bank share

2. **Competition effect:** Higher $\theta$ reduces C-banks’ competitive advantage ($\uparrow E^S/E^C$)  
   $\Rightarrow$ Higher $E^S$ reduces S-leverage & increases S-bank share

- Unambiguously positive effect on S-bank share
- Leverage: which effect dominates is a quantitative question
Key: HH’s liquidity demand parameters pinned down using
(1) aggregate liquidity premium (Van Binsbergen et al, 2019)
(2-3) S- & C-bank deposit spread sensitivity to S- & C-bank debt
(4) S-bank share based on Fed study (Gallin 2013)

- Model matches
  - Higher fragility of S-banks
  - Bank-dependent output and investment characteristics
Quantitative Effects: increase $\theta$ by 10pp

× 11% reduction in C-bank leverage

× S-bank deposit rate falls by 2%

× S-bank debt share increases by 7%

× S-bank leverage increases by only 80bps
  ⇒ Demand effect dominates but is counter-balanced by competition effect
  ⇒ Overall financial stability increases w/ $\theta$

▶ Welfare maximized at $\theta = 16\%$: trades-off reduction in liquidity provision against increase in consumption due to higher financial stability
Overview of this talk

1. 2-period model of the mechanism

2. Dynamic quantitative model
   - Differences to simple model
   - Calibration highlights
   - Quantitative results

3. Experiment: recovery after financial crisis
Setup

- Dates $t = 0$ and $t = 1$
  - Unit mass of HH endowed with 1 unit of capital at $t = 0$
  - C-banks and S-banks (unit mass) purchase capital financed with equity and deposit issuance to households
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  - Unit mass of HH endowed with 1 unit of capital at $t = 0$
  - C-banks and S-banks (unit mass) purchase capital financed with equity and deposit issuance to households
  - Capital produces 1 unit of consumption at $t = 1$ if held by banks
  - Capital much less productive if held by households

\[ U = C_0 + \beta (C_1 + \psi H (A_S, A_C)) \]

with $A_j, j = S, C$, are deposits of banks held by households
Setup

- Dates $t = 0$ and $t = 1$
  - Unit mass of HH endowed with 1 unit of capital at $t = 0$
  - C-banks and S-banks (unit mass) purchase capital financed with equity and deposit issuance to households
  - Capital produces 1 unit of consumption at $t = 1$ if held by banks
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- Household preferences: bank deposits provide liquidity services

\[ U = C_0 + \beta (C_1 + \psi H(A_S, A_C)) \]

with $A_j, j = S, C$, are deposits of banks held by households
Each bank solves

\[
\max_{K_S \geq 0, B_S \geq 0} q_S(B_S, K_S)B_S - pK_S + \beta \max \left\{ \rho_S K_S - B_S, 0 \right\}
\]

- equity raised at \( t = 0 \)
- dividend paid at \( t = 1 \)
Each bank solves

$$\max_{K_S \geq 0, B_S \geq 0} \left\{ q_S(B_S, K_S)B_S - pK_S + \beta \max \{ \rho S K_S - B_S, 0 \} \right\}$$

- equity raised at $t = 0$
- dividend paid at $t = 1$

Bank issues risky debt at price $q_S(B_S, K_S)$
- Creditors price default risk
- Bank internalizes effect of choice $(B_S, K_S)$ on debt price
Each bank solves

\[
\max_{K_S \geq 0, B_S \geq 0} \left\{ q_S(B_S, K_S) B_S - pK_S + \beta \max \left\{ \rho_S K_S - B_S, 0 \right\} \right\}
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- equity raised at \( t = 0 \)
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- Bank issues risky debt at price \( q_S(B_S, K_S) \)
  - Creditors price default risk
  - Bank internalizes effect of choice \( (B_S, K_S) \) on debt price

- Limited liability with costly bankruptcy: if default, equity is wiped out and all assets lost (no recovery for creditors)
Each bank solves

$$\max_{K_S \geq 0, B_S \geq 0} \left( q_S(B_S, K_S)B_S - pK_S + \beta \max \{ \rho_S K_S - B_S, 0 \} \right)$$

- Equity raised at \( t = 0 \)
- Dividend paid at \( t = 1 \)

Bank issues risky debt at price \( q_S(B_S, K_S) \)
- Creditors price default risk
- Bank internalizes effect of choice \( (B_S, K_S) \) on debt price

Limited liability with costly bankruptcy: if default, equity is wiped out and all assets lost (no recovery for creditors)

Bank-idiosyncratic payoff shock
Each bank solves

\[
\max_{K_C \geq 0, B_C \geq 0} \begin{cases} 
q_C B_C - pK_C \\ 
\text{equity raised at } t = 0 
\end{cases} + \beta \max \{ \rho_C K_C - B_C, 0 \} \\
\text{dividend paid at } t = 1
\]

subject to

\[
B_C \leq (1 - \theta)E(\rho_C) K_C
\]
Each bank solves

\[
\max_{K_C \geq 0, B_C \geq 0} \begin{cases} 
q_C B_C - pK_C & \text{equity raised at } t = 0 \\
\beta \max \{ \rho_C K_C - B_C, 0 \} & \text{dividend paid at } t = 1
\end{cases}
\]

subject to

\[
B_C \leq (1 - \theta)E(\rho_C)K_C
\]

Differences to S-bank problem

- Government-insured debt is riskfree to creditors
- Regulatory capital requirement \( \theta \)
HH choose purchases of debt and equity of each bank to max utility

\[
\max_{\{A_j, S_j\}_{j=s,c}} C_0 + \beta (C_1 + \psi H(A_S, A_C))
\]

s.t.

\[
C_0 = p \left( -q_S A_S - q_C A_C - p_S S_S - p_C S_C \right)
\]

sell cap. \hspace{2cm} buy securities

\[
C_1 = \left( 1 - L_S \right) A_S + A_C - T
\]

\[
+ S_S \frac{1}{2} K_S (1 - L_S)^2 + S_C \frac{1}{2} K_C (1 - L_C)^2
\]

div. from S-bank \hspace{2cm} div. from C-bank

where

\[
T = L_C B_C
\]

lump-sum taxes to bail out failing C-banks
Market clearing

\[ S_S = 1 \]
\[ S_C = 1 \]
\[ A_C = B_C \]
\[ A_S = B_S \]
\[ K_S + K_C = 1. \]

Resource constraints: \( C_0 = 0 \) and

\[ C_1 = \frac{1}{2} \left( 1 - K_C L_C^2 - K_S L_S^2 \right) \]

Time-1 consumption clarifies fundamental trade-off

- Bank leverage causes bankruptcies and deadweight losses
- But some leverage necessary to produce liquidity services
Decentralized Equilibrium: HH’s demand for S-bank and C-bank debt

- Define bank leverage $L_j = B_j/K_j$ and $F_S()$ is c.d.f. of $\rho_S$

- Household FOC for S-bank debt

\[ q(L_S) = \beta(1 - F_S(L_S) + \psi H_S(A_S, A_C)) \]

- Households FOC for C-bank debt

\[ q_C = \beta\left(1 + \psi H_C(A_S, A_C)\right) \]
Decentralized Equilibrium: S-Bank Problem

\[
\max_{K_S \geq 0, B_S \geq 0} q_S(B_S, K_S) B_S - pK_S + \beta \max \{\rho_S K_S - B_S, 0\}
\]

Define \( \rho_S^+ = \mathbb{E}(\rho_S | \rho_S > L_S) \)
Decentralized Equilibrium: S-Bank Problem

\[
\max_{K_S \geq 0, B_S \geq 0} q_S(B_S, K_S)B_S - pK_S + \beta \max \{\rho_S K_S - B_S, 0\}
\]

- Define \( \rho_S^+ = E(\rho_S | \rho_S > L_S) \)

- Optimization regarding \( L^S \) and \( A^S \) leads to
  1. Marginal default losses equal marginal liquidity benefit

\[
L_S f_S(L_S) = \psi H_S(A_S, A_C).
\]
Decentralized Equilibrium: S-Bank Problem

\[
\max_{K_S \geq 0, B_S \geq 0} q_S(B_S, K_S)B_S - pK_S + \beta \max \{\rho_S K_S - B_S, 0\}
\]

- Define \( \rho_S^+ = E(\rho_S | \rho_S > L_S) \)

- Optimization regarding \( L_S \) and \( A_S \) leads to
  1. Marginal default losses equal marginal liquidity benefit
     \[ L_S f_S(L_S) = \psi H_S(A_S, A_C). \]
  2. Constant returns implies S-banks earn zero expected profits
     \[ p = \beta ((1 - F_S(L_S))\rho_S^+ + \psi L_S H_S(A_S, A_C)). \]
Decentralized Equilibrium: C-Bank Problem

Similar to S-bank problem except for leverage constraint

\[ L_C \leq E(\rho_C)(1 - \theta), \]

As long as marginal benefit of C-bank liquidity positive, \( \psi H_C(A_S, A_C) > 0 \), the C-bank leverage constraint is always binding, implying \( L_C = E(\rho_C)(1 - \theta) \), and C-banks’ capital demand requires

\[ p = \beta \left( (1 - F_C(L_C))\rho_C^+ + \psi L_C H_C(A_S, A_C) + F_C(L_C)L_C \right). \]

Both banks value payout and collateral value of \( K_j \)

Plus, C-bank value \( K_C \) due to deposit insurance →
Leads to higher C-bank share

To compete, S-banks must provide higher payoff or liq. prem.
Assume liquidity preferences are

\[ H(A_S, A_C) = \frac{(\alpha A_S^\epsilon + (1 - \alpha) A_C^\epsilon)^{\frac{1-\gamma_H}{\epsilon}}}{1 - \gamma_H} , \]

with \( \gamma_H \geq 0, \epsilon \in (0, \infty) \)

- Planner maximizes household utility under \( \rho_S \sim \text{Uniform}[0, 1] \)

\[ \frac{A_S}{A_C} = \frac{K_S}{K_C} = \left( \frac{\alpha}{1 - \alpha} \right)^{\frac{1}{1-\epsilon}} \]

Relative size pinned down by liquidity preference

- Optimal leverage is equalized across bank types \( L_S = L_C = L^* \) as banks have identical technology to produce liquidity, where \( L^* \) is a function of parameters
Implications for Decentralized equilibrium

- Factor $m$ is a wedge b/w
  - Social marginal benefit of C-bank liquidity $\psi \mathcal{H}_C(A_S, A_C)$
  - Cost to society of producing this liquidity $L_C$

- In competitive equilibrium, C-banks overproduce liquidity, too much equity allocated to C-banks

- Competition effect means share of shadow banks in liquidity provision too small $\Rightarrow$ not fixed by capital requirement

- Competition effect induced via
  - Equity investors need to be indifferent b/w S- & C-banks
  - C-bank distortion extends to S-banks
Proposition

1. Holding constant all other parameters, an increase in the capital requirement $\theta$
   
   (i) reduces C-bank leverage,
   
   (ii) causes an expansion in the S-bank share: $\frac{d(A_s/A_c)}{d\theta} > 0$ and $\frac{d(K_s/K_c)}{d\theta} > 0$,
   
   (iii) can either raise or lower optimal S-bank leverage, depending on model parameters,

2. For $m \geq 0$, a marginal increase in the capital requirement improves aggregate welfare.
Ambiguous response of S-bank leverage

Raising $\theta$ in the model two effects

1. Competition Effect
   - Lowering C-bank leverage reduces equity return
   - Lowers competitive pressure on S-banks
   - c.p. *lowers* S-bank’s optimal leverage

2. Demand Effect
   - Decreasing returns to liquidity production, lower C-bank liquidity production increases marginal utility of liquidity
   - c.p. reduces $q_S$
   - c.p. *increases* S-bank’s optimal leverage

Which effect dominates depends on parameters!
- E.g. higher decreasing returns of liquidity services $\gamma_H$, stronger demand effect
Overview of this talk

1. 2-period model of the mechanism

2. Dynamic quantitative model
   - Differences to simple model
   - Calibration highlights
   - Quantitative results

3. Experiment: recovery after financial crisis
Dynamic Model: Key Differences

1. Infinite horizon model with bank-independent sector (endowment) and bank-dependent sector (production)
   - Banks have investment tech. w/ convex adj. costs
   - Convex capital adjustment costs

2. Riskier S-banks: runs and implicit bail-out guarantees
   - S-banks subject to stochastic deposit redemption shocks $\varrho_t$
   - More Details
   - Introduces additional losses through fire-sale
   - Government bails out S-bank *liabilities* with probability $\pi_B$
3. Risk averse households with preferences

$$U \left( C_t, H \left( A_t^S, A_t^C \right) \right) = \frac{C_t^{1-\gamma}}{1-\gamma} + \psi \left( \frac{\left[ \alpha (A_t^S)^{\epsilon} + (1-\alpha) (A_t^C)^{\epsilon} \right]^{\frac{1}{\epsilon}}}{1-\gamma_H} \right)^{1-\gamma_H}$$

- Portfolio choice of equity and debt of both types of banks
- Inelastic labor supply
State Variables and Solution Method

- **Exogenous states**
  \[
  \log(Y_{t+1}) = (1 - \rho_Y)\log(\mu_Y) + \rho_Y\log(Y_t) + \epsilon_{t+1}^Y \\
  Z_t = \phi^Z Y_t \exp(\epsilon_t^Z)
  \]

  and $\varrho_t$ follows a two-state Markov-process

- **Endogenous states**
  1. Capital stock
  2., 3. C-bank and S-bank debt
  4. S-bank capital share

- Solve using non-linear projection methods
  - Probability of default bounded in $[0, 1]$
  - Nonlinear dynamics because of bankruptcy option

- Report results for simulated model
Calibration: Consolidated View of Shadow Banks

```
<table>
<thead>
<tr>
<th>Finance Company</th>
<th>Money Market Mutual Funds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assets</td>
<td>Comm. Paper</td>
</tr>
<tr>
<td>Comm. Paper</td>
<td>Money Market Mutual Funds</td>
</tr>
<tr>
<td>Equity</td>
<td>MMMMF Shares</td>
</tr>
</tbody>
</table>

Consolidated

Shadow banks

Assets

Debt

Equity
```
## Table 2: Parameters that jointly match moments in the data

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
<th>Target</th>
<th>Data</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta$</td>
<td>0.993</td>
<td>Discount rate</td>
<td>C-bank debt rate</td>
<td>0.36%</td>
<td>0.39%</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>0.33</td>
<td>CES weight S-bank debt</td>
<td>Shadow banking share</td>
<td>34.0%</td>
<td>33.7%</td>
</tr>
<tr>
<td>$\psi$</td>
<td>0.0072</td>
<td>Liq. preference weight</td>
<td>Liq. premium BDG2019</td>
<td>0.21%</td>
<td>0.17%</td>
</tr>
<tr>
<td>$\gamma_H$</td>
<td>1.6</td>
<td>Liq. preference curvature</td>
<td>Reg. coefficient on AS</td>
<td>-0.19%</td>
<td>-0.14%</td>
</tr>
<tr>
<td>$\epsilon$</td>
<td>0.2</td>
<td>Liq. type elasticity</td>
<td>Reg. coefficient on AC</td>
<td>0.50%</td>
<td>0.68%</td>
</tr>
</tbody>
</table>

Notes: This table lists the parameters that jointly match the listed data moments. BDG2019 stands for Van Binsbergen, Diamond, and Grotteria (2019).
How are key liquidity preference parameters disciplined by data?

ψ: level of liquidity premium

- Van Binsbergen, Diamond, and Grotteria (2019) provide estimate of “risk-free rate w/o liquidity premium” based on option spreads
- ψ directly scales marginal liquidity benefit in model
Liquidity Preference Parameters (1/2)

- How are key liquidity preference parameters disciplined by data?
  - $\psi$: level of liquidity premium
    - Van Binsbergen, Diamond, and Grotteria (2019) provide estimate of “risk-free rate w/o liquidity premium” based on option spreads
    - $\psi$ directly scales marginal liquidity benefit in model
  - $\alpha$: market share of S-banks
    - Higher $\alpha$ raises S-bank relative to C-bank premium
    - Lowers funding cost, increases demand for capital of S-banks
Liquidity Preference Parameters (2/2)

\(\gamma_H \& \epsilon\): curvature & elasticity of subs. b/w S- & C-banks

- Determined by regression coefficients of spread on quantities

\[ q_t^C - q_t^S = E_t \left[ M_{t,t+1} \left( MRS_{t+1}^C - MRS_{t+1}^S + F_{\rho,t+1}^S \right) \right] \]

- Log-linear approximation of spread

- If \(\epsilon = 1\) (perfect substitutes) and \(\gamma_H = 0\) (CRS in liquidity), quantities of debt \((A_S, A_C)\) do not matter for spread

- Regression of spread b/w deposit price and 3month AA CP price on S-bank and C-bank money-like liabilities and controls, leads to coefficients of -0.19% on \(A_S\) and 0.50% on \(A_C\)

- Matched in model with \(\epsilon = 0.20\) (net substitutes) and \(\gamma_H = 1.60\)
### Other important parameters: Quarterly data 1999 – 2019

<table>
<thead>
<tr>
<th>Values</th>
<th>Target</th>
<th>Data</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bank leverage and default</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\delta_S$</td>
<td>0.390</td>
<td>Corp. bond default rate</td>
<td>0.28%</td>
</tr>
<tr>
<td>$\delta_C$</td>
<td>0.204</td>
<td>Net loan charge-offs</td>
<td>0.23%</td>
</tr>
<tr>
<td>$\xi_C$</td>
<td>0.352</td>
<td>Secured recov. rate Moody’s</td>
<td>48.1%</td>
</tr>
<tr>
<td>$\xi_S$</td>
<td>0.205</td>
<td>Unsecured recov. rate Moody’s</td>
<td>38.1%</td>
</tr>
<tr>
<td>$\pi_B$</td>
<td>0.85</td>
<td>Shadow bank leverage</td>
<td>87.0%</td>
</tr>
<tr>
<td><strong>Runs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\delta_K$</td>
<td>2.5%</td>
<td>Avg. haircut (GM 2009)</td>
<td>15.1%</td>
</tr>
</tbody>
</table>
Increasing Capital Requirement

Larger shadow banking share, C-banks “exit”, S-bank “enter”
Demand effect dominates competition effect: higher S-bank leverage

<table>
<thead>
<tr>
<th>1. Capital</th>
<th>Benchmark mean</th>
<th>13% mean</th>
<th>16% mean</th>
<th>20% mean</th>
<th>30% mean</th>
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<tbody>
<tr>
<td>2. Debt share S</td>
<td>32%</td>
<td>+2.7%</td>
<td>+4.6%</td>
<td>+6.9%</td>
<td>+13.8%</td>
</tr>
<tr>
<td>3. Leverage S</td>
<td>0.831</td>
<td>+0.2%</td>
<td>+0.4%</td>
<td>+0.8%</td>
<td>+1.8%</td>
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<td>4. Leverage C</td>
<td>0.899</td>
<td>-3.3%</td>
<td>-6.7%</td>
<td>-11.2%</td>
<td>-22.2%</td>
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<td>5. Early Liquidation (runs)</td>
<td>0.004</td>
<td>+0.3%</td>
<td>+0.6%</td>
<td>+1.1%</td>
<td>+2.5%</td>
</tr>
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| 6. Deposit rate S | 0.45% | -0.7% | -1.6% | -3.1% | -6.8% |
| 7. Deposit rate C | 0.39% | -3.7% | -7.2% | -12.0% | -26.8% |
| 8. Conv. Yield S | 0.28% | +1.4% | +3.3% | +6.3% | +14.3% |
| 9. Conv. Yield C | 0.31% | +4.7% | +9.1% | +15.2% | +34.0% |
Increasing Capital Requirement

C-banks become safer, but S-banks riskier

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<td>3.15</td>
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Interest rates fall as liquidity premia rise ⇒ more investment

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<td>+0.4%</td>
<td>+0.7%</td>
<td>+1.6%</td>
</tr>
<tr>
<td>2. Debt share S</td>
<td>32%</td>
<td>+2.7%</td>
<td>+4.6%</td>
<td>+6.9%</td>
<td>+13.8%</td>
</tr>
<tr>
<td>3. Leverage S</td>
<td>0.831</td>
<td>+0.2%</td>
<td>+0.4%</td>
<td>+0.8%</td>
<td>+1.8%</td>
</tr>
<tr>
<td>4. Leverage C</td>
<td>0.899</td>
<td>-3.3%</td>
<td>-6.7%</td>
<td>-11.2%</td>
<td>-22.2%</td>
</tr>
<tr>
<td>5. Early Liquidation (runs)</td>
<td>0.004</td>
<td>+0.3%</td>
<td>+0.6%</td>
<td>+1.1%</td>
<td>+2.5%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Prices</th>
<th></th>
<th>13%</th>
<th>16%</th>
<th>20%</th>
<th>30%</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. Deposit rate S</td>
<td>0.45%</td>
<td>-0.7%</td>
<td>-1.6%</td>
<td>-3.1%</td>
<td>-6.8%</td>
</tr>
<tr>
<td>7. Deposit rate C</td>
<td>0.39%</td>
<td>-3.7%</td>
<td>-7.2%</td>
<td>-12.0%</td>
<td>-26.8%</td>
</tr>
<tr>
<td>8. Conv. Yield S</td>
<td>0.28%</td>
<td>+1.4%</td>
<td>+3.3%</td>
<td>+6.3%</td>
<td>+14.3%</td>
</tr>
<tr>
<td>9. Conv. Yield C</td>
<td>0.31%</td>
<td>+4.7%</td>
<td>+9.1%</td>
<td>+15.2%</td>
<td>+34.0%</td>
</tr>
</tbody>
</table>
## Increasing Capital Requirement

Defaults from C-banks decline, from S-banks rise

<table>
<thead>
<tr>
<th></th>
<th>BM mean</th>
<th>13% mean</th>
<th>16% mean</th>
<th>20% mean</th>
<th>30% mean</th>
<th>Welfare</th>
</tr>
</thead>
<tbody>
<tr>
<td>10. Default Rate S</td>
<td>0.30%</td>
<td>+3.1%</td>
<td>+7.4%</td>
<td>+14.1%</td>
<td>+34.1%</td>
<td></td>
</tr>
<tr>
<td>11. Default Rate C</td>
<td>0.23%</td>
<td>-65.1%</td>
<td>-89.4%</td>
<td>-98.3%</td>
<td>-100.0%</td>
<td></td>
</tr>
<tr>
<td>12. GDP</td>
<td>1.29</td>
<td>+0.0%</td>
<td>+0.1%</td>
<td>+0.1%</td>
<td>+0.2%</td>
<td></td>
</tr>
<tr>
<td>13. Liquidity Services</td>
<td>1.48</td>
<td>-2.2%</td>
<td>-4.22%</td>
<td>-7.0%</td>
<td>-14.1%</td>
<td></td>
</tr>
<tr>
<td>14. Consumption</td>
<td>1.21</td>
<td>+0.1%</td>
<td>+0.1%</td>
<td>+0.1%</td>
<td>+0.1%</td>
<td></td>
</tr>
<tr>
<td>15. HH Welfare</td>
<td></td>
<td>+0.04%</td>
<td>+0.05%</td>
<td>+0.4%</td>
<td>+0.04%</td>
<td></td>
</tr>
</tbody>
</table>
## Increasing Capital Requirement

More consumption and lower liquidity provision

<table>
<thead>
<tr>
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<tr>
<td>Welfare</td>
<td></td>
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<p>| | | | | |</p>
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<td>+0.04%</td>
<td>+0.05%</td>
<td>+0.4%</td>
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</table>
Increasing Capital Requirement

Welfare maximized at 16%

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<td></td>
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<tr>
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<td>+0.04%</td>
</tr>
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</table>
Experiment: Recovery from the Financial Crisis

► Effects of a Basel III shift in capital req in our model?

► Simulate 2008/2009 crisis and subsequent increase in cap req

► Pre 2008/2008 features: lax capital requirements & agents underestimate risk of run on shadow banking system (Moreira and Savov, 2017)

► Relative to bnckm calibration: pre-crisis has a lower capital requirement and higher S-bank bailout prob. and zero perceived prob. of S-bank run.

► Shock: run on S-banks and bad productivity shock

► Regulators increase cap req to 11% over 3 years and reduce S-bank bailout prob.
Recovery from the Financial Crisis

This figure plots the time path of several model variables in a simulation of the 2008 financial crisis. The y-axis denotes percentage deviations from the initial state for the four panels in the top row, and percent in the four bottom panels. The solid black lines with circles plot the baseline simulation described in the text that raises capital requirements to 11% post-crisis. The dotted blue line includes the same parameter changes as the black line, except the increase in capital requirements. For the bottom four panels, the dashed line plots data counterparts to the model variables as described in Appendix D.4.
Conclusion

- Tractable quantitative GE model with two types of banks
- Increasing capital requirement on commercial banks
  - makes C-banks less, S-banks more profitable
  - leads to larger and riskier S-bank sector
  - less liquidity provision
  - no negative effects on production and investment in total
- Welfare trade-off: greater consumption (fewer bank failures) versus reduced liquidity provision
- Key Model Lessons
  - Quantitative force of either demand or competition effect depends on semi-well understood parameters governing
    - Liquidity preference of HH
    - Competition between S-bank & C-bank
  - Slight increase in S-bank risk does not undermine intended benefits of tighter capital regulation
Fraction of Liquid Wealth in MMA at Household Level

Source: 2013 SCF
\[ v^S(Z_t) = \max_{b_{t+1}^S \geq 0, k_{t+1}^S \geq 0} k_{t+1}^S (q_s(b_{t+1}^S)b_{t+1}^S - p_t) - \frac{\phi K}{2} (k_{t+1}^S - 1)^2 \]

\[ + k_{t+1}^S \mathbb{E}_t \left[ M_{t,t+1} \Pi_{t+1}^S \Omega^S(L_{t+1}^S) \right], \]

with

\[ \Omega^S(L_t^S) = (1 - F_{\rho,t}^S) \left( \rho_t^{S,+} (1 - \ell_t^S (1 - x_t^S)) - L_t^S + (1 - \ell_t^S) \frac{\nu^S(Z_t)}{\Pi_t^S} \right) - F_{\rho,t}^S \delta_S \]

- **Endogenous liquidation (fraction of assets)**

\[ \ell_t^S = \frac{\rho_t^S B_t^S}{K_t^S \Pi_t^H} \]

- **Probability of default** \( F_{\rho,t}^S = F_{\rho}^S(\hat{\rho}_t^S) \) with threshold
C-bank default

- Government bails out liabilities of failing C-banks
- Recovers

\[
    r^C(L^C_t) = (1 - \xi^C) \frac{\rho^{C,-}_t}{L^C_t}
\]

per bond issued by C-banks
C-bank default

- Government bails out liabilities of failing C-banks
- Recovers

\[ r^C(L^C_t) = (1 - \xi^C)(\rho^C_t \frac{\xi^C}{L^C_t}) \]

per bond issued by C-banks

S-banks default

- Benchmark: government does not bailout failing S-banks
- Bailout for S-bank with probability \( \pi_B \)
- Recovery value per bond

\[ r^S(L^S_t) = (1 - \xi^S)(1 - \ell^S_t(1 - x_t)) \frac{\rho^S_t}{L^S_t} \]
Bankruptcy & Deposit Insurance

- C-bank default
  - Government bails out liabilities of failing C-banks
  - Recovers
    
    \[ r^C(L^C_t) = (1 - \xi^C) \frac{\rho^C_{t,-}}{L^C_t} \]

    per bond issued by C-banks

- S-banks default
  - Benchmark: government does not bailout failing S-banks bails out liabilities of failing S-bank with probability \( \pi_B \)
  - Recovery value per bond
    
    \[ r^S(L^S_t) = (1 - \xi^S)(1 - \ell^S_t (1 - x_t)) \frac{\rho^S_{t,-}}{L^S_t} \]

- Required taxes in addition to deposit insurance revenue

\[ T = F^C_{\text{net}} (1 - C(L^C)) \frac{R^C}{L^C} + F^S_{\text{net}} (1 - S(L^S)) \frac{R^S}{L^S} + T^B \]