Financial Regulation in a Quantitative Model of the Modern Banking System

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Motivation

- **Financial System:**
  - regulated (commercial) banks & unregulated (shadow) banks
    - provide access to “intermediated” assets, e.g. long term credit
    - balance sheet: risky & illiquid assets funded with money-like liabilities

- Effects of financial regulation on a subset of banks?
  - Does tighter regulation cause shift to shadow banks?
  - Does it make financial system more risky?

- Requires quantitative general equilibrium analysis
- Study effect of capital requirements
This Paper

Model
- comm. banks and shadow banks provide liquidity services
- both have limited liability & costly bankruptcies
- comm. banks: deposit insurance, subject to capital regulation
- shadow banks: risky debt, no regulation
- focus on (1) risk taking through bank leverage
  (2) liquidity provision by banks

Calibration matches
- aggregate liquidity premium of safe debt
- size of shadow banking sector
- default risk of both types of banks
- greater fragility of shadow banks (runs)

Tighter capital requirement
- causes shift to shadow sector
- only small increase in risk taking (leverage) by shadow banks
- trade-off between financial fragility and liquidity provision
Model Overview

Intermediaries

Commercial Banks

Capital

Deposits

Equity

Capital produced by banks

Deposit Insurance

$\phi$ deposits withdrawn early & bailout probability

Shadow banks

Capital

Debt

Equity

Households

Y Asset

Own Funds

C. Deposits

S. Debt

C. Equity

S. Equity

Y Asset (not intermediated)
Overview of Talk

- **Static Model**
  - What pins down size and leverage of shadow banks?
  - Effect of tighter capital requirement
  - Efficient allocation vs. equilibrium

- **Dynamic quantitative model**
  - Differences to simple model
  - Calibration highlights
  - Quantitative results
Setup

- Dates $t = 0$ and $t = 1$
  - Unit mass of households endowed with 1 unit of capital at $t = 0$
  - Unit mass of C-banks and S-bank purchase capital and issue equity and debt to households
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  - Capital produces 1 unit of consumption at $t = 1$ if held by banks
  - Capital much less productive if held by households
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  - Unit mass of households endowed with 1 unit of capital at $t = 0$
  - Unit mass of C-banks and S-bank purchase capital and issue equity and debt to households
  - Capital produces 1 unit of consumption at $t = 1$ if held by banks
  - Capital much less productive if held by households

- 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

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

where:
- \( q_S(B_S, K_S)B_S \) is the equity raised at \( t = 0 \)
- \( pK_S \) is the dividend paid at \( t = 1 \)
- \( \beta \) is a discount factor
- \( \rho S K_S - B_S \) is the bank-idiosyncratic payoff shock
S-banks

▶ 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 $t = 1$

▶ 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
S-banks

- Each bank solves

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

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

- Each bank solves
  \[
  \max_{K_S \geq 0, B_S \geq 0} \left\{ \begin{array}{l}
  q_S(B_S, K_S)B_S - pK_S \\
  \beta \max \{ \rho_S K_S - B_S, 0 \}
  \end{array} \right.
  \]
  where
  - 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 \( \rho_S \sim \text{Uniform}[0, 1] \)
S-Bank Problem

- Write time-1 dividend as

\[
\max \{\rho_S K_S - B_S, 0\} = K_S (1 - F_S(L_S)) (E(\rho_S | \rho_S > L_S) - L_S)
\]

with bank leverage \( L_S = B_S / K_S \) and \( F_S() \) is c.d.f. of \( \rho_S \)
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with bank leverage \(L_S = B_S / K_S\) and \(F_S()\) is c.d.f. of \(\rho_S\)

- Using \(\rho_S \sim \text{Uniform}[0, 1]\), \(F_S(L_S) = L_S\) is default probability, and continuation value further simplifies

\[
\frac{1}{2} K_S (1 - L_S)^2
\]
S-Bank Problem

- Write time-1 dividend as

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  \frac{1}{2} K_S (1 - L_S)^2
  \]

- Using scale independence

  \[
  \nu_S = \max_{L_S \in [0,1]} q_S(L_S) L_S - p + \beta \frac{1}{2} (1 - L_S)^2
  \]

  \[
  \max_{K_S \geq 0} K_S \nu_S
  \]
Each bank solves

\[
\begin{align*}
\max_{K_C \geq 0, B_C \geq 0} & \quad q_C B_C - p K_C + \beta \max \left\{ \rho_C K_C - B_C, 0 \right\} \\
\text{equity raised at } t = 0 & \quad \text{dividend paid at } t = 1
\end{align*}
\]

subject to

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

- Each bank solves

\[
\begin{align*}
\max_{K_C \geq 0, B_C \geq 0} & \quad q_C B_C - p K_C + \beta \max \left\{ \rho_C K_C - B_C, 0 \right\} \\
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\end{align*}
\]

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 \( \theta \)
Households and Government

- HH choose purchases of debt and equity of each bank to max utility

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

s.t. $C_0 = \begin{cases} p & \text{sell cap.} \\ -q_s A_S - q_c A_C - p_s S_S - p_c S_C & \text{buy securities} \end{cases}$

$$C_1 = (1 - L_S)A_S + A_C - T$$

$$+ S_s \frac{1}{2} K_S (1 - L_S)^2 + S_C \frac{1}{2} K_C (1 - L_C)^2$$

where

$$T = L_C B_C$$

are lump-sum taxes required to bail out liabilities of failing C-banks
Equilibrium

- 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
Planner Problem (1/2)

- Planner solves

\[
\max_{K_S, L_S, L_C} \frac{1}{2} (1 - (1 - K_S)L_C^2 - K_S L_S^2) + \psi H \left( \begin{array}{c}
L_S K_S = A_S \\
L_C(1 - K_S) = A_C
\end{array} \right)
\]

- Liquidity preference function

\[
H(A_S, A_C) = (\alpha A_S^\epsilon + (1 - \alpha) A_C^\epsilon)^{1/\epsilon}
\]
Planner Problem (1/2)

- Planner solves

\[
\max_{K_S, L_S, L_C} \frac{1}{2} (1 - (1 - K_S)L_C^2 - K_SL_S^2) + \psi H \left( \begin{array}{c}
L_SL_S \\L_C(1 - K_S)
\end{array} \right) \begin{array}{c}
= A_S \\
= A_C
\end{array}
\]

- Liquidity preference function

\[
H(A_S, A_C) = \left( \alpha A_S^\epsilon + (1 - \alpha) A_C^\epsilon \right)^{1/\epsilon}
\]

- Marginal liquidity benefit (\text{"convenience yield"})

\[
\frac{\partial H(A_S, A_C)}{\partial A_j} = H_j(R_S), \text{ where } R_S = A_S/A_C
\]
Planner Problem (1/2)

- Planner solves

\[ \max_{K_S, L_S, L_C} \frac{1}{2} \left( 1 - (1 - K_S)L_C^2 - K_SL_S^2 \right) + \psi H \left( \frac{L_SK_S}{=A_S}, \frac{L_C(1 - K_S)}{=A_C} \right) \]

- Liquidity preference function

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

- Marginal liquidity benefit (‘‘convenience yield’’)

\[ \frac{\partial H(A_S, A_C)}{\partial A_j} = H_j(R_S), \text{ where } R_S = A_S/A_C \]

- Solution is

\[ \frac{K_S}{K_C} = \left( \frac{\alpha}{1 - \alpha} \right)^{\frac{1}{1-\epsilon}}, \text{ and } L_S = L_C \]

with \( L_S = \psi H_S(R_S) \) and \( L_C = \psi H_C(R_S) \)
Planner Problem (2/2)

- How does planner set leverage of each bank?

\[ L_j = \psi H_j(A_S/A_C) \]

- RHS is marginal benefit to household from liquidity
- LHS is marginal cost from failing banks (consumption losses)
- \( L_S = L_C \) means that same marginal benefit from both types

▶ Greater elasticity \( 1/(1-\epsilon) \) tilts allocation towards bank with greater weight in CES aggregator
Planner Problem (2/2)

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- RHS is marginal benefit to household from liquidity
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- \( L_S = L_C \) means that same marginal benefit from both types

- How does planner allocate capital?

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

- Both banks have same production technology for consumption good
- So capital allocation only based on liquidity production technology
- Greater elasticity \( 1/(1 - \epsilon) \) tilts allocation towards bank with greater weight in CES aggregator
Equilibrium Characterization: S-Bank Problem

▶ S-bank FOC for leverage

\[ q'_S(L_S)L_S + q(L_S) = \beta(1 - L_S) \]

▶ Household FOC for S-bank debt

\[ q(L_S) = \beta \left(1 - L_S + \psi H_S(R_S)\right) \]

\[ \text{payoff} \quad \text{liq. premium} \]

▶ Combining gives

\[ L_S = \psi H_S(R_S) \]

⇒ S-bank leverage choice is same as planner solution!

▶ Constant returns also imply zero expected profits

\[ \nu_S = 0 \Leftrightarrow p - q_S(L_S)L_S = \beta \frac{1}{2} (1 - L_S)^2 \]
Equilibrium Characterization: C-Bank Problem

- Simplify problem as for S-bank

\[ v_C = \max_{L_C \in [0,1]} q_C L_C - p + \beta \frac{1}{2} (1 - L_C)^2 \]

subject to

\[ L_C \leq \frac{1}{2} (1 - \theta) , \]

and \[ \max_{K_C \geq 0} K_C v_C \]

- Household FOC for C-bank debt

\[ q_C = \beta ( \frac{1}{\text{payoff}} + \psi H_C (R_S) ) \]

\[ \text{liq. premium} \]
Equilibrium Characterization: C-Bank Problem

- Simplify problem as for S-bank

  \[
  \nu_C = \max_{L_C \in [0,1]} q_CL_C - p + \beta \frac{1}{2} (1 - L_C)^2
  \]

  subject to

  \[
  L_C \leq \frac{1}{2} (1 - \theta) ,
  \]

  and \( \max_{K_C \geq 0} K_C \nu_C \)

- Household FOC for C-bank debt

  \[
  q_C = \beta \left( \frac{1}{\text{payoff}} + \psi H_C(R_S) \right)
  \]

- C-bank constraint always binds if \( \psi > 0 \): \( L_C = \frac{1}{2} (1 - \theta) \)

  \( \Rightarrow \) Moral hazard due to limited liability and deposit insurance
Equilibrium Characterization: C-Bank Problem

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- Constant returns also imply zero expected profits

\[ \nu_C = 0 \iff p - q_C L_C = \beta \frac{1}{2} (1 - L_C)^2 \]
Equilibrium Characterization: Relative Size of Sectors

- Rewrite zero-profit conditions

S-bank: \[ p = \beta \frac{1}{2} (1 + L_S^2) \]

C-bank: \[ p = \beta \frac{1}{2} (1 + L_C^2) + \beta L_C \psi H_C(R_S) \]

- Combining both conditions to get indifference condition

\[ L_S = (L_C^2 + L_C \psi H_C(R_S))^{1/2} \]

- Condition implies that S-bank leverage is always higher than C-bank leverage

- C-bank has key competitive advantage: deposit insurance

- To deliver same profit to equity owners, S-banks need to have higher leverage (holding constant S-bank default risk)

- Also recall optimal S-bank leverage

\[ L_S = \psi H_S(R_S) (L_C) \]
Equilibrium Characterization: Relative Size of Sectors

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  S-bank: \( p = \beta \frac{1}{2} (1 + L_S^2) \)

  C-bank: \( p = \beta \frac{1}{2} (1 + L_C^2) + \beta L_C \psi H_C (R_S) \)

- Combining both conditions to get indifference condition

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Equilibrium Characterization: Relative Size of Sectors

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  \[ p = \beta \frac{1}{2} (1 + L_S^2) \]  
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  - Condition implies that S-bank leverage is always higher than C-bank leverage
  - C-bank has key competitive advantage: deposit insurance
  - To deliver same profit to equity owners, S-banks need to have higher leverage (holding constant S-bank default risk)

- Also recall optimal S-bank leverage

  \[ L_S = \psi H_S(R_S) \quad (L2) \]
Equilibrium Characterization: Relative Size of Sectors

- Red line: indifference condition
  \[ L_S = \left( \frac{1}{4}(1 - \theta)^2 + \frac{1}{2}(1 - \theta)\psi H_C(R_S) \right)^{1/2} \]

- Blue line: leverage condition \( L_S = \psi H_S(R_S) \)

- Key property: decreasing returns, i.e. \( H'_S(R_S) < 0 \) and \( H'_C(R_S) > 0 \)
Effect of Higher $\theta$

- Indifference condition $L_S = \frac{1}{4}(1 - \theta)^2 + \frac{1}{2}(1 - \theta)\psi H_C(R_S)^{1/2}$ \downarrow
- Higher $\theta$ makes C-banks less profitable and S-banks relatively more profitable $\Rightarrow$ S-bank sector expands: $R_S \uparrow$
- But decreasing returns $\Rightarrow$ lower S-bank liquidity premium $\Rightarrow L_S \downarrow$
How Should Regulator Set $\theta$?

Proposition

Index competitive equilibria by the factor $m > -1$, such that

$$L_C = (1 + m)\psi H_C(R_S),$$

and the function $\theta = f(m)$ that determines the value of $\theta$ implementing equilibrium $m$.

(i) There is no $\theta \in [0, 1]$ that implements the planner allocation.

(ii) In any equilibrium with $m \geq 0$, an increase in the capital requirement $\theta$ is welfare-improving.

- Planner wants $L_C = \psi H_C(R_S)$, so could choose $\theta = f(0)$
- But always have $L_S > L_C$ in equilibrium due to deposit insurance and competition $\Rightarrow$ need additional policy tool to regulate S-banks
- Still welfare-improving to raise $\theta$ in world with $m > 0$
Effect With More General Preferences

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

- Ambiguous net effect of higher $\theta$
  - makes C-banks less profitable and shadow bank equity more attractive
  - shadow bank share expands, liqu. premium on S-bank debt declines relative to C-bank debt
  - with $\gamma_H > 0$, marginal benefit of total liquidity goes up as $H(A_S, A_C)$ falls and leverage curve shifts up

1. makes C-banks less profitable and shadow bank equity more attractive
2. shadow bank share expands, liquidity premium on S-bank debt declines relative to C-bank debt
3. with $\gamma_H > 0$, marginal benefit of total liquidity goes up as $H(A_S, A_C)$ falls and leverage curve shifts up
Overview of Talk

▶ Static Model
  ▶ What pins down size and leverage of shadow banks?
  ▶ Effect of tighter capital requirement
  ▶ Efficient allocation vs. equilibrium

▶ Dynamic Quantitative Model
  ▶ Differences to simple model
  ▶ Calibration highlights
  ▶ Quantitative results
Dynamic Model: Key Differences

1. Infinite horizon model with bank-independent sector (endowment) and bank-dependent sector (production)
   ▶ Banks have access to standard investment technology
   ▶ Convex capital adjustment costs

2. Riskier S-banks: runs and implicit bail-out guarantees
   ▶ S-banks subject to stochastic deposit redemption shocks $\rho_t$
   ▶ Introduces additional losses through fire-sale
   ▶ Government bails out S-bank liabilities with probability $\pi_B$

3. Risk averse households with preferences

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

   ▶ 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 \( \rho_t \) 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

[Diagram showing the consolidation of assets, liabilities, and equity between Finance Company, Money Market Mutual Funds, and Shadow banks.]

Begenau & Landvoigt
Financial Regulation
24 / 33
## Key Parameters: Quarterly data 1999 – 2015

<table>
<thead>
<tr>
<th>Values</th>
<th>Target</th>
<th>Data</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \delta_S )</td>
<td>0.300</td>
<td>Quarterly corp. bond default rate</td>
<td>0.36%</td>
</tr>
<tr>
<td>( \delta_C )</td>
<td>0.175</td>
<td>Quarterly net loan charge-offs</td>
<td>0.25%</td>
</tr>
<tr>
<td>( \xi_C )</td>
<td>0.515</td>
<td>Recovery rate Moody’s</td>
<td>63%</td>
</tr>
<tr>
<td>( \xi_S )</td>
<td>0.415</td>
<td>Recovery rate Moody’s</td>
<td>63%</td>
</tr>
<tr>
<td>( \pi_B )</td>
<td>0.905</td>
<td>Shadow bank leverage</td>
<td>93%</td>
</tr>
</tbody>
</table>

### Bank leverage and default

### Liquidity preferences

| \( \beta \) | 0.993   | C-bank debt rate | 0.39% | 0.39% |
| \( \alpha \) | 0.330   | Shadow banking share (Gallin 2013) | 35% | 34% |
| \( \psi \) | 0.0103  | Liquidity premium C-banks; KV2012 | 0.18% | 0.17% |
| \( \gamma_H \) | 1.700   | Corr(GDP, C-bank liquid. premium) | -0.28 | -0.39 |
| \( \epsilon \) | 0.420   | S-bank liquidity elasticity | 0.17% | 0.16% |

### Runs

| \( \delta_K \) | \( 4 \times \delta_K \) | Max. haircut (GM 2009) | 20% | 19% |
| \( Z \) | 26% \times Z | Forecl. discount (Campbell et al 2011) |
| \( \rho \) | \([0, 0.3]\) | Fraction run |
| \( \text{Prob}_\rho \) | \[
\begin{bmatrix}
0.97 & 0.03 \\
0.33 & 0.67 \\
\end{bmatrix}\] | Uncond. run prob. (Covitz et al 2013) | 3% | 3% |
Liquidity Preference Parameters (1/2)

-how are key liquidity preference parameters disciplined by data?

- $\psi$: level of liquidity premium
  - Krishnamurthy & Vissing-Jorgenson 2012 estimate annual premium of 75 bps
  - $\psi$ directly scales marginal liquidity benefit in model
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  - Higher $\alpha$ raises S-bank relative to C-bank premium
  - Lowers funding cost, increases demand for capital of S-banks
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  - $\alpha$: 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
  - $\gamma_H$: comovement of premium with GDP
    - Countercyclical in data: liquidity is abundant in good times, so premium is low
    - Model matches countercyclical premium with $\gamma_H = 1.7 \Rightarrow$ downward-sloping demand curve for liquidity
\[ \hat{q}_t^C - \hat{q}_t^S = \beta \left( \frac{MRS^C}{q^C} - \frac{MRS^S}{q^S} \right) \gamma \hat{C}_{t+1} + \frac{\beta F^S}{q^S} \hat{F}_{t+1} \]
\[ + \beta \left( (1 - \epsilon - \gamma_H) \left( \frac{MRS^C}{q^C} - \frac{MRS^S}{q^S} \right) \right) (1 - \alpha) \left( \frac{A^C}{H} \right)^\epsilon - (1 - \epsilon) \left( \frac{MRS^C}{q^C} \right) \hat{A}_{t+1}^C \]
\[ + \beta \left( (1 - \epsilon - \gamma_H) \left( \frac{MRS^C}{q^C} - \frac{MRS^S}{q^S} \right) \right) \alpha \left( \frac{A^S}{H} \right)^\epsilon + (1 - \epsilon) \left( \frac{MRS^S}{q^S} \right) \hat{A}_{t+1}^S \]

- \( \epsilon \): elasticity of substitution between S- and C-bank debt
  - Log-linear approximation of spread \( 1/q_S - 1/q_C \) (shadow rate – deposit rate)
  - If \( \epsilon = 1 \) (perfect substitutes) and \( \gamma_H = 0 \) (CRS in liquidity), quantities of debt \( (A_S, A_C) \) do not matter for spread
  - If \( \epsilon < 1 \), would expect negative sign on \( A_C \) and positive sign on \( A_S \)
  - Regression of CP – Tbill spread on Tbill supply, shadow debt supply (and controls) gives elasticity of 17 bp
  - Matched in model with \( \epsilon = 0.42 \) (net substitutes)
Increasing Capital Requirement

Larger shadow banking share, C-banks “exit”, S-bank “enter”

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<thead>
<tr>
<th>Benchmark</th>
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<tbody>
<tr>
<td>Capital</td>
<td>4.005</td>
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<tr>
<td>Debt share S</td>
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## Increasing Capital Requirement

C-banks become safer, but S-banks riskier

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Increasing Capital Requirement

Interest rates fall as liquidity premia rise ⇒ more investment

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Increasing Capital Requirement

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

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<tr>
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<tr>
<td>14. Default Rate C</td>
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</tr>
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<td>17. Consumption</td>
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<td>+0.19%</td>
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<td>+0.24%</td>
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<td>18. Vol(Liquidity Services)</td>
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<td>19. Vol(Consumption)</td>
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<td>+10.5%</td>
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<td>+0.129%</td>
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Increasing Capital Requirement

More consumption and lower liquidity provision

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Begenau & Landvoigt
Financial Regulation
Transition Dynamics
Other Policies

- Set time-varying insurance fee such that fund breaks even
  - Fair $\kappa$ does not reduce C-bank leverage, but shifts activity to S-bank
  - $\Rightarrow$ Less liquidity provision and higher deadweight losses

<table>
<thead>
<tr>
<th></th>
<th>$\theta=17%$</th>
<th>fair $\kappa$</th>
<th>$\text{Corr}(\theta_t, Y_t)$ $&lt; 0$</th>
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Other Policies

- Set cyclical capital req’s with mean 17%
  - similar effects as with static optimal $\theta$
Other Policies

- “Minneapolis plan”: $\theta = 23\%$ and tax on S-bank debt of 30 bps
  - Shrinks S-banks while making C-bank safer
  - Large drop in liquidity production, but greatest overall welfare gain
  - Consistent with welfare analysis in simple model: both banks have too high leverage in status quo

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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
  - GE effects (e.g. deposit rate response to higher cap reg)
  - Nature of 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
\[ v^S(Z_t) = \max_{b^S_{t+1} \geq 0, k^S_{t+1} \geq 0} \ k^S_{t+1} \left( q_s(b^S_{t+1}) b^S_{t+1} - p_t \right) - \frac{\phi K}{2} \left( k^S_{t+1} - 1 \right)^2 \]

\[ + k^S_{t+1} E_t \left[ M_{t,t+1} \Pi^S_{t+1} \Omega^S(L^S_{t+1}) \right], \]

with

\[ \Omega^S(L^S_t) = (1 - F^S_{\rho,t}) \left( \rho^S_{t,+} \left( 1 - \ell^S_t \left( 1 - x^S_t \right) \right) - L^S_t + (1 - \ell^S_t) \frac{v^S(Z_t)}{\Pi^S_t} \right) - F^S_{\rho,t} \delta_S \]

- **Endogenous liquidation (fraction of assets)**
  \[ \ell^S_t = \frac{\rho^S_t B^S_t}{K^S_t \Pi^H_t} \]

- **Probability of default** \( F^S_{\rho,t} = F^S_\rho(\hat{\rho}^S_t) \) with threshold
  \[ \hat{\rho}^S_t = \frac{L^S_t - (1 - \ell^S_t) \frac{v^S(Z_t)}{\Pi^S_t} - \delta_S}{1 - \ell^S_t \left( 1 - x^S_t \right)} \]

Increasing in leverage, liquidation fraction, and fire sale discount
Bankruptcy & Deposit Insurance

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

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

per bond issued by C-banks
Bankruptcy & Deposit Insurance

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

\[ r^C(L_t^C) = (1 - \xi^C) \frac{\rho_{t}^{C,-}}{L_t^C} \]

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

\[ r^S(L_t^S) = (1 - \xi^S)(1 - \ell_t^S(1 - x_t)) \frac{\rho_{t}^{S,-}}{L_t^S} \]
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**

\[
 T_t = F^C_{\rho,t}(1 - r^C(L^C_t))B^C_t - \kappa B^C_{t+1} + \pi_B F^S_{\rho,t}(1 - r^S(L^S_t))B^S_t
\]

Net payment to defaulting C-bank depositors

Bailout for S-bank