Financial Regulation in a Quantitative Model of the Modern Banking System

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January 29, 2016
MFM Winter Meeting 2016

Motivation

- Financial intermediation sector
  - provides access to "intermediated" assets
  - turns risky & illiquid assets into safe & liquid liabilities
- Traditional banks: money-like liabilities, deposit insurance, capital regulation
- Shadow banks: no guarantees and little regulation, liabilities less money-like
- Unintended consequences of regulating a subset of banks

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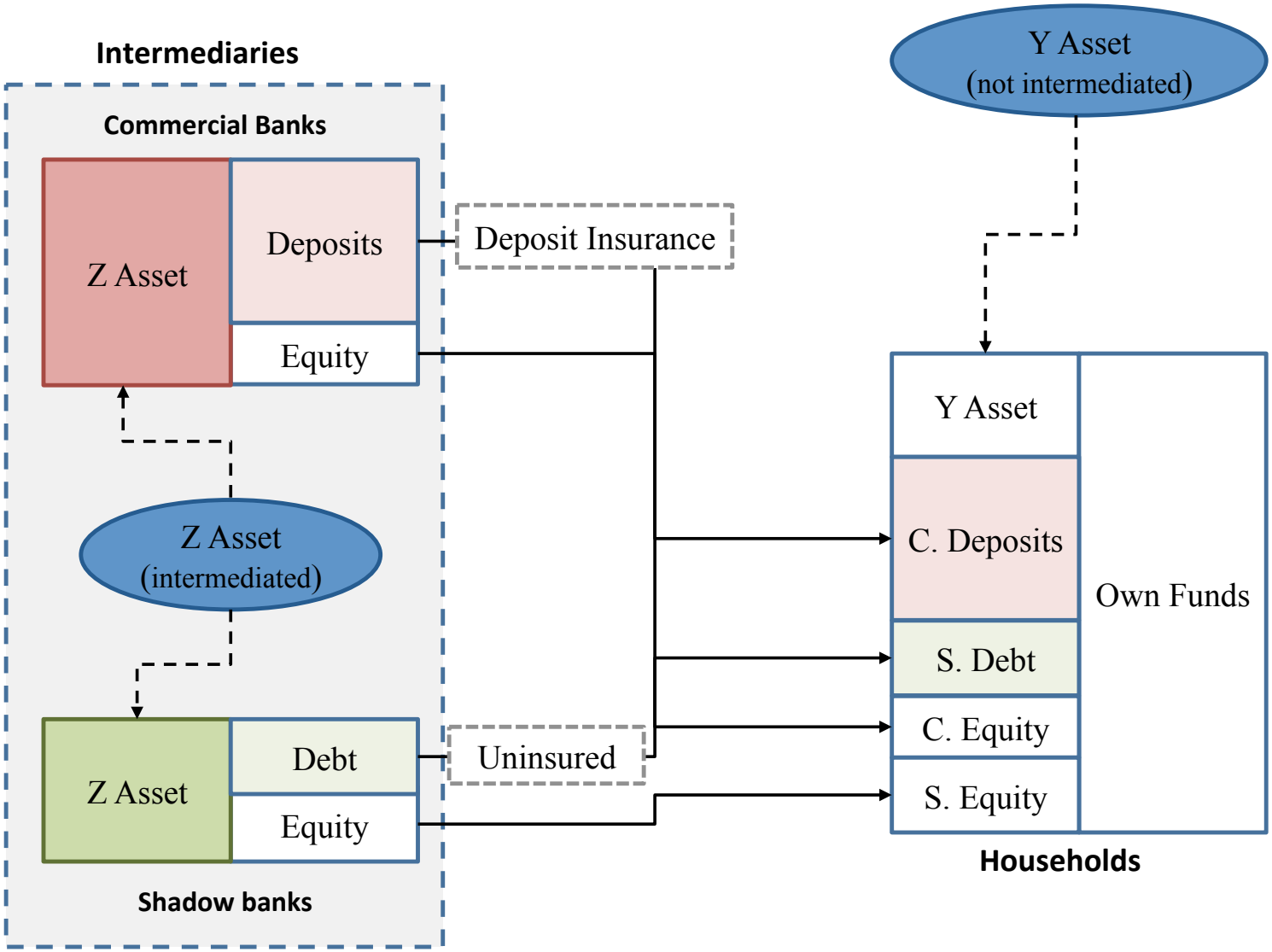
- This paper
  - develops general equilibrium model to study & quantify effects of capital regulation on different intermediaries
  - provides framework for designing optimal capital requirement

Model Overview



Preview of Findings

1. Raising capital requirement from 10% to 20% leads to
   - increase in shadow banking share
     - 9 pp higher asset share
     - 6 pp higher liquidity service share
     - not monotonic: if increase req further, lower shadow share
   - less financial fragility
     - bankruptcy rate of C-banks drops to 0%
     - bankruptcy rate of S-banks drops to 0.1%
   - higher asset prices
     - price of intermediated asset rises by 20%
     - equity of both types becomes more valuable

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2. Welfare
   - Optimal requirement trades off financial stability against less liquidity
   - At low level of capital charge, C-banks overproduce liquidity due to deposit insurance
   - Higher requirement
     - reduces bank failures, increases consumption
     - reduces liquidity provision
   - Dynamic model: lower volatility of consumption at higher requirement

Two-period Model

- At $t = 0$,
  - HH buy intermediaries'
    - equity: shares S^S, S^C at prices p^S, p^C
    - and debt: bonds N^S, N^C at prices q^S, q^C
  - receive income Y_0
- At $t = 1$, HH receive
  - intermediary securities' payoff:
    - equity of non-bankrupt C-banks, S-banks
    - debt of C-banks safe
    - payoff of S-banks' debt depends on bankruptcy, and recovery value
  - stochastic income Y_1
- HH preferences

$$U(C_0, C_1, H) = \log(C_0) + \beta \left(\log(C_1) + \psi \frac{(H/C_1)^{1-\eta}}{1-\eta} \right)$$

  - Liquidity $H = \left[(1-\nu) \left(N^S\right)^{\alpha} + \nu \left(N^C\right)^{\alpha} \right]^{1/\alpha}$
  - Liquidity factor ν depends on default rate of S-banks

Intermediaries

- At $t = 0$, portfolio choice of j-bank, i, $\forall\ j \in (S, C)$
  - buy A_i^j shares of intermediated asset at price p
  - issue debt B_i^j at price q^j
- At $t = 1$, assets pay off and bank suffers idiosyncratic loss ρ_i^j, with ρ_i^j i.i.d across banks & time

$$A_j^C(Z - \rho_j^C) - B_j^C$$

- Banks defaults if $\rho_i^j > Z - B_i^j/A_i^j$
  - Probability of survival $F_\rho^C(Z - B_i^C/A_i^C)$
  - Expected value of shock conditional on survival and failure

$$\begin{aligned}\rho_j^- &= \mathrm{E}^\rho[\rho_i^C \mid \rho_i^j < Z - B_i^j/A_i^j] \\ \rho^+ &= \mathrm{E}^\rho[\rho_i^C \mid \rho_i^j > Z - B_i^j/A_i^j]\end{aligned}$$

- Bank problem homogeneous of degree one in A_i^j: define leverage $b_i^j = B_i^j/A_i^j$ and aggregate across banks i of type j

Intermediaries (ctd.)

- Commercial banks
  - Make portfolio and leverage choice
  - Can default, bankruptcy cost
  - Deposit insurance, pay insurance fee κ
  - Capital requirement $(1-\theta)p \geq b^C$
- Shadow banks analogous to C-banks, but
  - no formal deposit insurance
  - not subject to regulatory capital requirement
  - individual S-bank internalizes effect of its portfolio choice on its credit risk through bond price $q^S(b_i^S)$
    $\Rightarrow$ "endogenous" leverage constraint
  - Does not internalize effect on liquidity service value in HH's utility

Competitive Equilibrium

Given realizations $\{Y_1, Z\}$, choices

$\{S^S, S^C, N^S, N^C, C_0, C_1\}$ for households

$\{A^C, B^C\}$ for C-banks

$\{A^S, B^S\}$ for S-banks

and prices $\{p^S, p^C, q^S, q^C, p\}$ such that all agents optimize and all asset markets clear

$$\begin{aligned} 1 &= A^S + A^C \\ N^S &= B^S \\ N^C &= B^C \\ S^S &= 1 \\ S^C &= 1 \end{aligned}$$

Goods market at $t = 1$

$$C_1 = Y_1 + Z - \sum_j A^j \left[\xi_j (1 - F^j)(Z - \rho_j^+)\right], \; j = C, S$$

Leverage in Equilibrium

- HH FOCs for C-bank and S-bank debt

$$q^C = \mathrm{E}_0\left[M\left(1 + MU_{N^C}/MU_{C1}\right)\right]$$
$$q^S = \mathrm{E}_0\left[M\left(F_\rho^S + (1 - F_\rho^S)r^S + MU_{N^S}/MU_{C1}\right)\right]$$

- C-bank and S-bank FOC for leverage (uniform distribution for ρ^j)

$$q^C - \kappa = \lambda^C + \mathrm{E}_0\left[M\, F_\rho^C\right]$$
$$q^S(b^S) = -b^S \frac{\partial q^S(b^S)}{\partial b^S} + \mathrm{E}_0\left[M\, F_\rho^S\right]$$

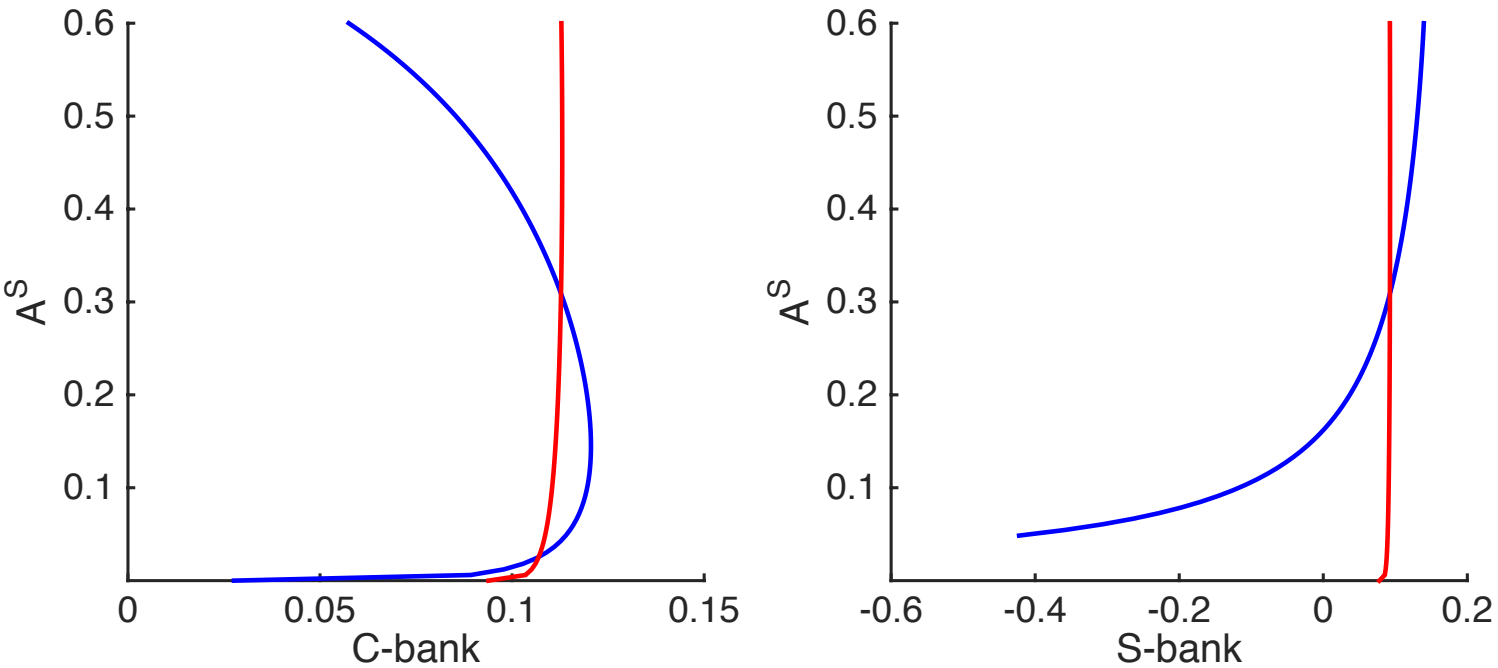
- Implications for leverage choice
  - C-bank constraint always binding ($\lambda^C > 0$)
  - S-bank leverage limited by $\partial q^S(b^S)/\partial b^S < 0$

Relative Size of Sectors

FOCs for C-bank and S-bank asset purchases

$$p - q^S b^S = \mathrm{E}_0 \left[M F_\rho^S (Z - b^S) \left(Z - b^S - \rho_S^- \right) \right]$$

$$\underbrace{p - \left(q^C - \kappa \right) b^C}_{\text{Cost in blue at } t=0} = \underbrace{\mathrm{E}_0 \left[M F_\rho^C (Z - b^C) \left(Z - b^C - \rho_C^- \right) \right]}_{\text{Payoff in red at } t=1}$$



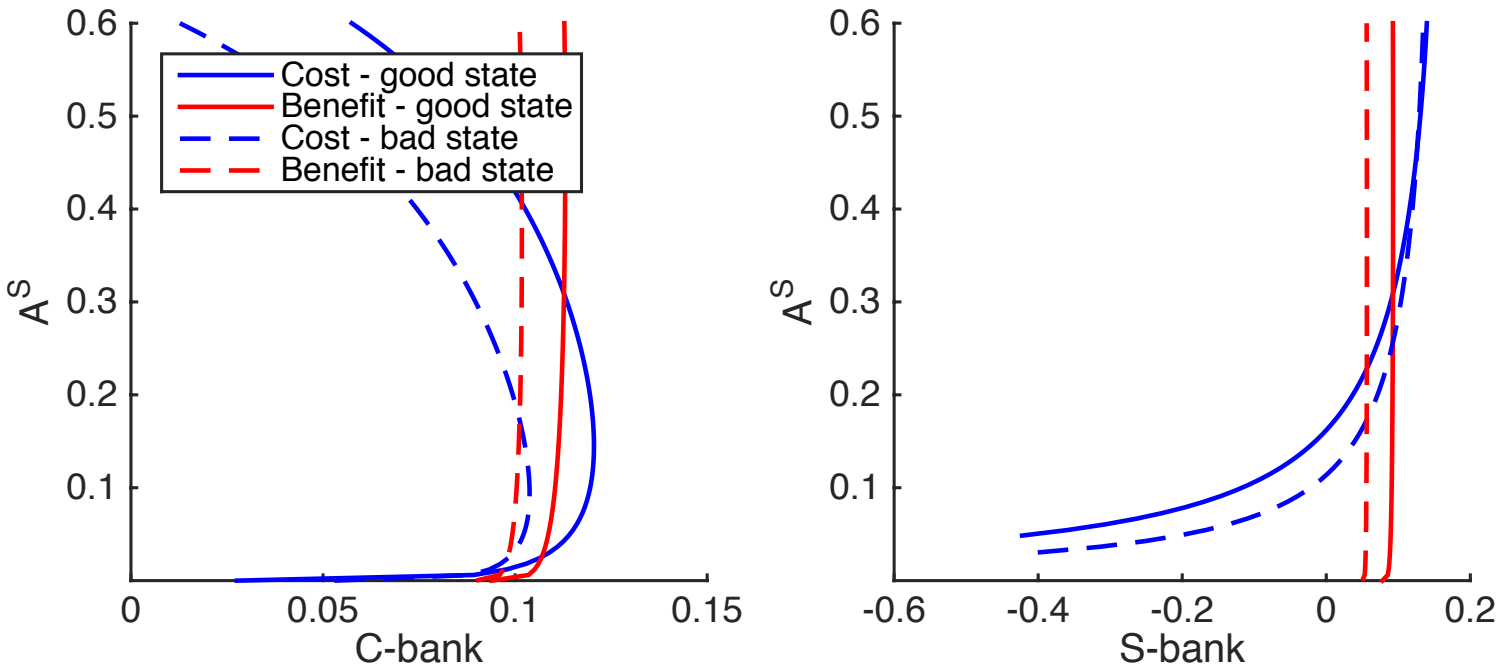
Procyclical Shadow Bank Share

Relative quality of S-bank liquidity is time-varying

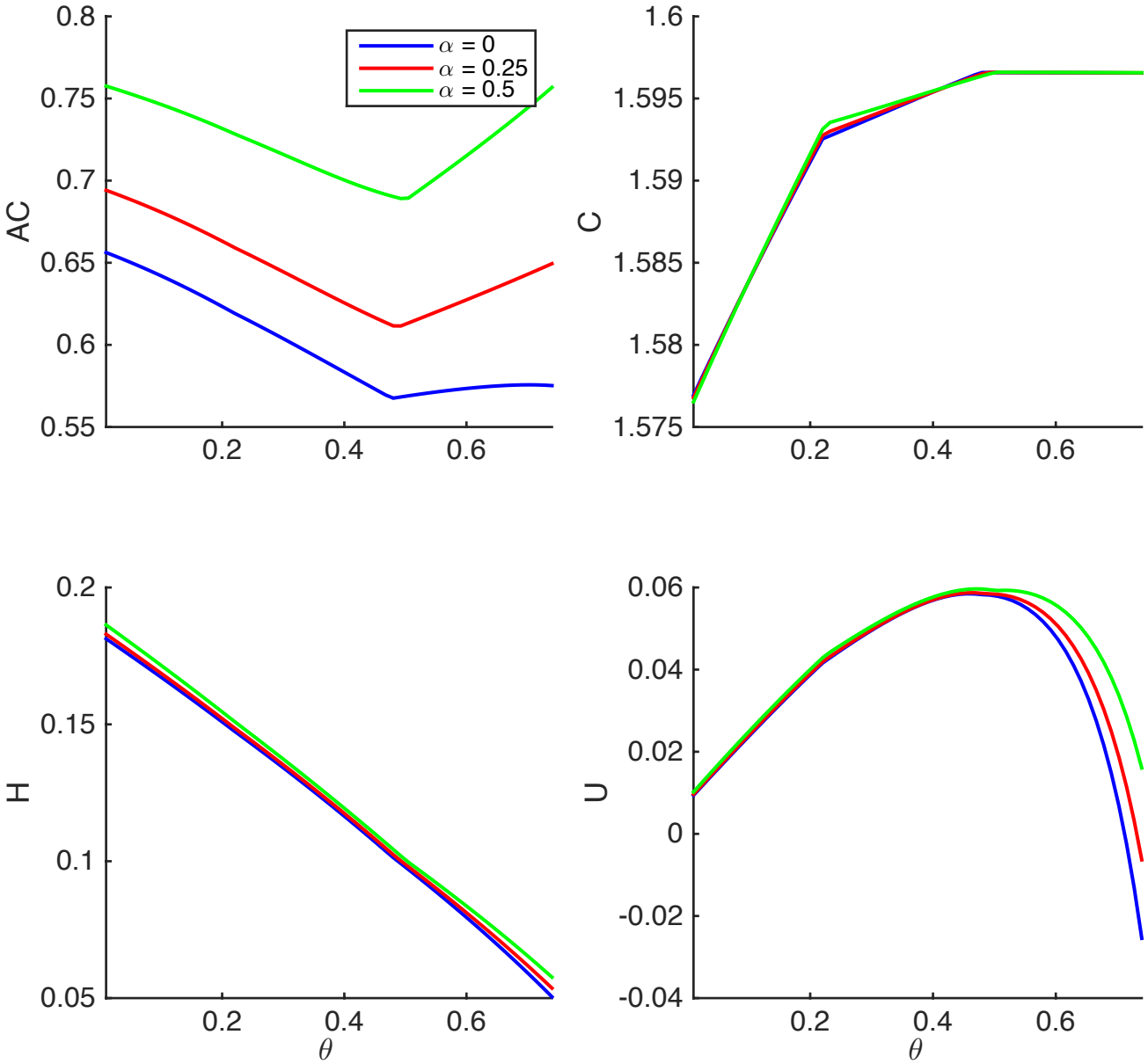
$$H = \left[(1-\nu) \left(N^S \right)^{\alpha} + \nu \left(N^C \right)^{\alpha} \right]^{1/\alpha}$$

with

$$1 - \nu = \frac{\left(F^S \right)^{\tilde{\nu}}}{1 + \left(F^S \right)^{\tilde{\nu}}}$$



Optimal Capital Requirement: Basic Trade-off



Dynamic Model

- Fundamentally same economic forces, but additional predictions about
  - effect of policy on volatility of consumption, liquidity provision
  - cyclicality of C-bank, S-bank leverage

- Exogenous states

$$\log(Y_{t+1}) = (1-\rho_Y)\log(\mu_Y) + \rho_Y \log(Y_t) + \epsilon^Y_{t+1}$$
$$Z_t = \phi_Z Y_t \exp(\epsilon^Z_t)$$

- Endogenous states
  - Shadow bank asset share A^S_t
  - Net worth of commercial bank
  - Net worth of shadow bank

- Solve using 2nd-order approximation

Dynamic Model: Calibration

Parameters	Function	Value	Target
β	discount rate	0.99	Literature
α	maps into CES par.	0.63	$S-$bank share / Gallin Flow of Fund
ν	liquidity factor	2	spread on $C-$& $S-$bank debt CP AA fin.- FDIC r exp, 2.17%
ψ	utility weight on safe assets	0.5	$S-$bank book leverage 30
κ	deposit insurance fee	0.0006168	deposit ins. rates(25 bp p.a)
θ	$C-$ bank capital req.	0.10	Effective Tier 1 cap ratio
ξ_ρ^C	bankruptcy loss	0.4	recovery rate (37.1%)
ξ_ρ^S	bankruptcy loss	0.3	recovery rate (37.1%)
η	compl. bw cons & safe assets	2	vol(consumption/safe assets)
σ_ρ^C	vol of ρ shock	0.033	FDIC default rate 0.04 %
σ_ρ^S	vol of ρ shock	0.18	q^S: FRED CP ON AA fin. sector
σ^Z	vol of Z shock	0.0008	normalized fin. sector income vol
μ^Y	mean of Y	0.1	normalization
ρ^Y	persistence of Y	0.85	normalization
σ^Y	vol of Y shock	0.0063	agg. TFP vol

Dynamic Model: Main Result

S-bank share increasing, then decreasing in θ

	$\theta = 0.1$		$\theta = 0.15$		$\theta = 0.20$		$\theta = 0.25$	
	mean	stdev	mean	stdev	mean	stdev	mean	stdev
	Exogenous Variables							
Fin.Sec Income	0.007	0.004	0.007	0.004	0.007	0.004	0.007	0.004
Asset payoff	0.10	0.005	0.10	0.005	0.10	0.005	0.10	0.005
	Intermediated asset share & price							
S-bank share	0.42	0.053	0.55	0.016	0.51	0.011	0.49	0.011
Asset price	6.96	0.626	8.47	0.582	8.17	0.532	8.19	0.534
	Bank debt & prices							
C-bank debt	3.59	0.186	3.44	0.216	3.34	0.196	3.27	0.186
S-bank debt	0.48	0.136	0.80	0.058	0.73	0.055	0.72	0.054
S debt price	0.989	0.091	0.988	0.045	0.988	0.033	0.988	0.033
C debt price	0.981	0.088	0.994	0.046	0.991	0.035	0.991	0.035
	Consumption & welfare							
Liquidity	1.67	0.134	1.91	0.118	1.82	0.112	1.78	0.108
Consumption	0.190	0.009	0.198	0.009	0.200	0.008	0.200	0.008
Welfare[a]			4.19%	-23.82%	4.72%	-25.82%	4.69%	-25.69%

Dynamic Model: Main Result

Price of intermediated asset increases by 20% as θ is raised

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Price increase so large that total liquidity initially increases, even as both banks reduce liquidity services

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Liquidity decreases for high levels of θ, welfare maximum around $\theta = 22\%$

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Additional welfare gain through lower volatility of consumption & liquidity

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Conclusion

- Quantitative general equilibrium model with two types of financial institutions
  - Deposit insurance for commercial banks
  - Endogenous leverage limit for shadow banks
- Increasing capital requirement on regulated banks
  - causes increase in shadow bank activity from current level, but effect non-monotonic
  - leads to higher prices of intermediated assets, as shadow banks have higher marginal valuation
- Welfare gain from increase
  - higher capital charge eliminates default risk in both sectors
  - reduces liquidity provision only for very large increase
- Lower volatility of prices, consumption in dynamic economy with greater capital requirement
- Including production will allow to assess effect on investment, output