Capital Requirements, Risk Choice, and Liquidity Provision in a Business Cycle Model

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Motivation

- How to regulate banks?
- Capital requirement: min equity/ risky assets
- Literature: higher capital requirements
  - limit banks' risk-taking
  - reduce lending and liquidity provision

This paper:

- develops general equilibrium model to quantify trade-offs
- derives optimal capital requirement
- shows importance of effect of capital requirements on endogenous prices
- mechanism is based on household's demand for safe assets

Quantitative GE model

- Main features
  - banks are essential for a part of production
  - households' preference for safe & liquid bank debt
  - banks receive government subsidy
- Quantified with data from the FDIC and NIPA
- Consistent with business cycle facts
  - macroeconomic variables
  - banking sector aggregates

Findings

Optimal capital requirement

- 14% of risky assets

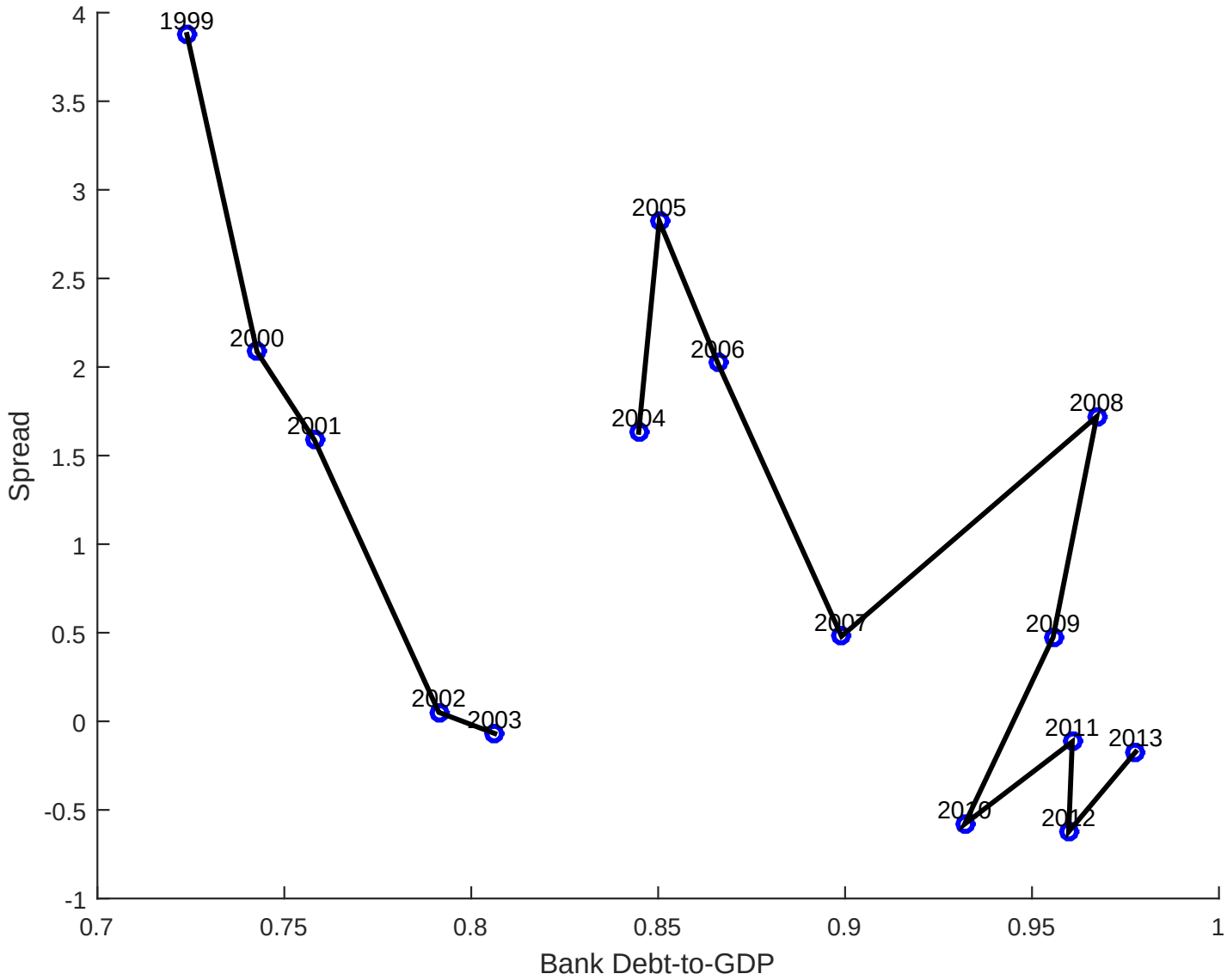
Increasing the capital requirement to 14%

- reduces the supply of liquid bank debt by 9%
- reduces volatility of income-risky-asset ratio by 6%
- *increases* loans by 2%

Main proposition:
Higher capital requirements leading to a reduction in the supply of bank debt can in fact result in *more lending*

Core assumption:
Investors value safe and liquid assets in the form of bank debt more the scarcer they are

Corporate bond spread and bank debt



The figure plots the spread between the Aaa corporate bond rate and the implied interest rate on bank debt against the bank debt-to-GDP ratio for 1999-2013.

Related literature

- Banks' role for production
  - Diamond 1984; Sharpe 1990; Boyd & Prescott 1986; Holmström & Tirole 1997; Winton 2000; Van Den Heuvel 2002; Bolton & Freixas 2006
  - James 1978; Hoshi, Kashyap & Scharfstein 1991; Gertler & Gilchrist 1992; Dell'Ariccia, Detragiache & Rajan 2008; Iacoviello & Minetti 2008
- Households' demand for liquid bank debt
  - Diamond & Dybvig 1983; Gorton & Winton 1995; Diamond & Rajan 2000; Kashyap, Rajan & Stein 2002; Van Den Heuvel 2008; Williamson 2012; Dang, Gorton, Holmström & Ordonez 2013; DeAngelo & Stulz 2013; Allen, Carletti & Marquez 2014
  - Bansal & Coleman 1996; Krishnamurthy & Vissing-Jørgensen 2013; Greenwood, Hanson & Stein 2014
- Risk-shifting incentives
  - Kareken & Wallace 1978; Keeley & Furlong 1990; Gennotte & Pyle 1991; Schneider & Tornell 2004; Farhi & Tirole 2011; Admati et al 2013; Allen, Carletti, Goldstein & Leonello 2014
  - Kelly, Lustig & Nieuwerburgh 2012; Gandhi & Lustig 2012; Marques, Correa & Sapriza 2013; Duchin & Sosyura 2014
- Quantification of capital requirements
  - Corbae & D'Erasmo 2011, 2012; Christiano & Ikeda 2013; Clerc et al 2014; Nguyen 2014; Martinez-Miera & Suarez 2014

Outline

- Mechanism
- Model
- Trade-off Description
- Taking the model to the data
- Welfare

Two-sector business cycle model

- Technology f : non-bank dependent

$$y_t^f = Z_t^f \left(k_{t-1}^f\right)^{\alpha} \left(N_t^f\right)^{1-\alpha}$$

- Technology h : banking sector funded activities as part of the overall output (collateralized lending)

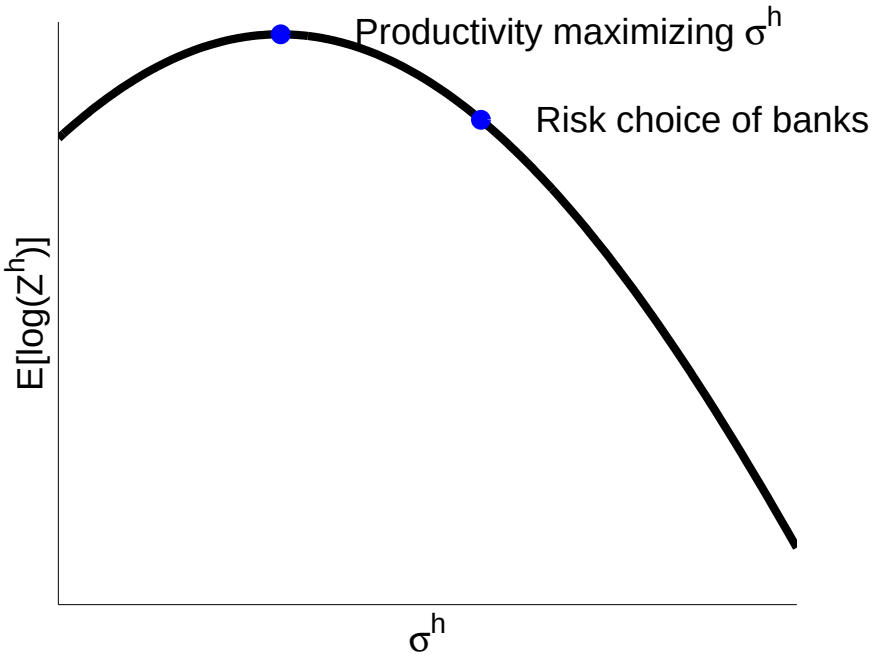
$$y_t^h = Z_t^h \left(k_{t-1}^h\right)^{v}$$

- Banks run h production directly
- Choose investment and risk

Banks' risk-return trade-off

- Captures menu of investment choices
- Z_t^h productivity level in $y_t^h = Z_t^h \left(k_{t-1}^h\right)^v$

$$\log Z_{t+1}^h\left(\sigma_t^h\right) = \rho^h \log Z_t^h\left(\sigma_{t-1}^h\right) + \left(\phi_1 - \phi_2 \sigma_t^h\right)\sigma_t^h + \sigma_t^h \epsilon_{t+1}^h$$



- σ_t^h determines mean and exposure to aggregate shock

Balance sheet and profits

- Balance sheet at the beginning of t

$$k^h_{t-1} + b_{t-1} = e_{t-1} + s_{t-1}$$

- Profits

$$\pi_t = \underbrace{y^h_t - \delta^h k^h_{t-1}}_{\text{income from } k^h} + \underbrace{r^B_t b_{t-1}}_{\text{interest inc.}} - \underbrace{r_t s_{t-1}}_{\text{interest exp.}}$$

- Capital requirement

$$e_t \geq \xi k^h_t$$

Subsidy to banks

- Capture effects of guarantees on banks' liabilities
  - Assume: government cannot commit to not bailout banks
  - Guarantees subsidize leverage and risk-taking
- Unlimited liability and explicit subsidy

$$TR_t = \omega_3 \underbrace{k^h_{t-1}}_{\text{size}} \exp\left(-\omega_1 \underbrace{\frac{e_{t-1}+\pi_t}{k^h_{t-1}}}_{\text{capitalization}} + \omega_2 \underbrace{\sigma^h_t}_{\text{risk-taking}} \right)$$

$\omega_1, \omega_2, \omega_3 > 0$

- Implies complementarity between leverage and risk-taking

Banks' problem

- Maximize present value of dividend payout d_t subject to

$$d_t = \pi_t + TR_t - \Delta e_t - \frac{\kappa}{2}\left(d_t - \bar{d}\right)^2 - \text{adj}_{k^h}$$

- Dividend smoothing motive captured with dividend adjustment costs

Households

- Utility of households

$$U\left(c_t, s_t\right) = \log c_t + \theta \frac{\left(s_t / c_t\right)^{1-\eta}}{1-\eta}$$

  where $\eta > 1$.

- Net worth of households

$$\begin{aligned} n_t &= \left(d_t + p_t\right)\Theta_{t-1} + \left(1 + r_t\right) s_{t-1} \\ &\quad + \left(r_t^f + 1 - \delta^f\right) k_{t-1}^f \\ &\quad - \text{Taxes} \end{aligned}$$

- Maximize discounted expected utility subject to the budget constraint

$$c_t + s_t + k_t^f + p_t \Theta_t = n_t + w_t^f N_t^f$$

Recursive competitive equilibrium

- State vars: capital stocks, productivity levels, households' net worth, equity after profits
- Exog. shocks to $\log Z^h$ & $\log Z^k$
- Given prices, households, firms, and banks optimize
- Policies satisfy market clearing for bonds, bank debt, capital stocks, labor, bank shares, and consumption.
- Gov budget constraint holds: $TR + Br^B =$ Taxes

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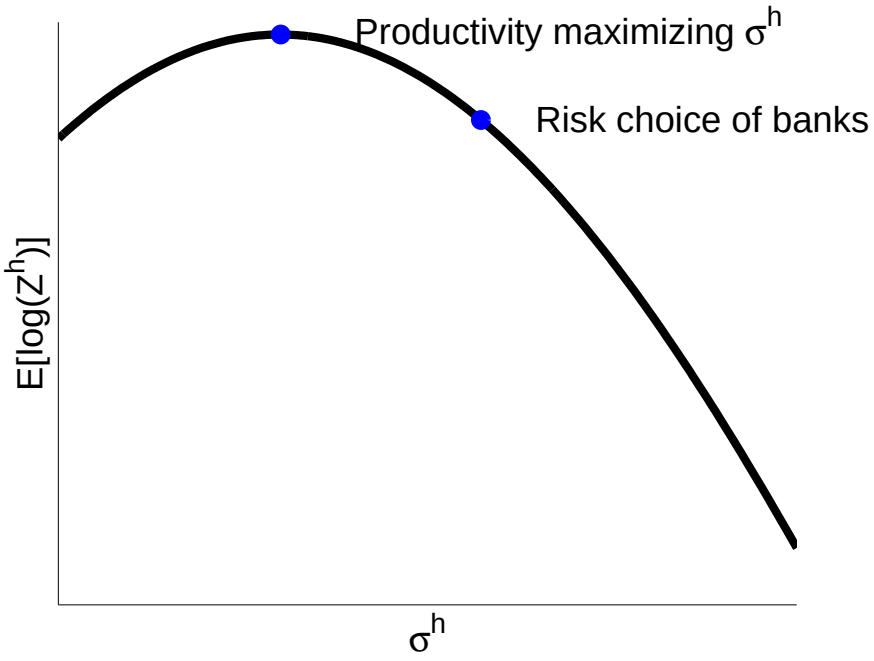
Decisions relevant for trade-off

- Risk choice
- Leverage choice
- Lending choice

Risk choice

- Subsidy: source of excessive risk-taking



- Higher ξ : reduce σ^h and increase $E\left[\log\left(Z^h\right)\right]$

Leverage choice

- Households' FOC wrt liquid bank debt:

$$\frac{r^e - r}{1 + r^e} = U_s(c, s) / U_c(c, s) > 0$$

$\Rightarrow r^e = \frac{1}{\beta} - 1 > r$

- Discount on bank debt $\rightarrow$ binding capital requirement: $e = \xi k^h$
  - debt is preferred
  - gov. subsidy adds to this
- What happens to r when s falls?
  - $r^e - r$ larger the scarcer s
  - reduction in s leads to reduction in r

Lending choice

$$\underbrace{1 + v\frac{y^h}{k^h} - \delta^h + g\left(\frac{TR}{k^h}\right)}_{\textit{Benefit of } k^h} = \underbrace{\xi\left(1 + r^e\right) + \left(1 - \xi\right)\left(1 + r\right)}_{\textit{Funding costs of } k^h}$$

- Higher capital requirements
  $\rightarrow$ With rates fixed: banks want to reduce scale
  $\rightarrow$ Reduction in debt reduces r through GE
  $\rightarrow$ Overall funding costs fall if ξ not too large
- Fall in funding costs$\rightarrow$ banks want to increase k^h
- Strength depends on key parameters: η and v

Welfare effects of capital requirements

Increase in the capital requirement

- reduces risk-taking
- reduces liquidity through a reduction in bank debt
- increases assets through lower funding costs

Optimal capital requirement

- trades-off reduction in liquidity against reduction in risk-taking and an increase in consumption

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Mapping from model to data

Model	NIPA and FDIC balance sheet & inc stat.
y^h: bank output	income− sec int. income
k^h: bank capital	loans + trading assets
y^f : firm output	NIPA total GDP − bank output
k^f : firm capital	NIPA $K - k^h$
c: consumption	NIPA consumption
s: bank debt	bank liabilities
π: profits	net income + non interest expense
r: rate on bank debt	interest expenses / bank liabilities
σ^h: risk choice	std of BC component $\log(y_h/k_h)$
e: equity	tier 1 equity

Period: 1999q1:2013q4

Quantification of Parameters

1. natural data counterpart
   - e.g. persistences of productivity shocks
2. using steady state conditions of the model and targeting moments one for one
   - e.g. time preference rate of households
3. jointly
   - e.g. parameters governing adjustment costs, liquidity preference, and size of banking sector

Key parameters

Par.	Governs	Target Moment	Value
η	hh dislike for changes in bank debt/ consum. strength of $\downarrow r$ to $\uparrow \xi$	vol(bank liab/cons)	3.15
v	conversion of risky assets into bank output strength of $\uparrow k^h$ to $\uparrow \xi$	inc/risky assets	0.30

Business cycle correlations

	GDP	
	Data	Model
Investment	0.97	0.98
Consumption	0.94	0.87
Bank income	0.66	0.64
Bank risky assets	0.37	0.32
Bank liabilities	0.31	0.32
Interest rate on bank liabilities	0.68	0.64
Bank income-risky assets	0.61	0.62
Bank profit	0.34	0.64
Bank investment	0.46	0.55

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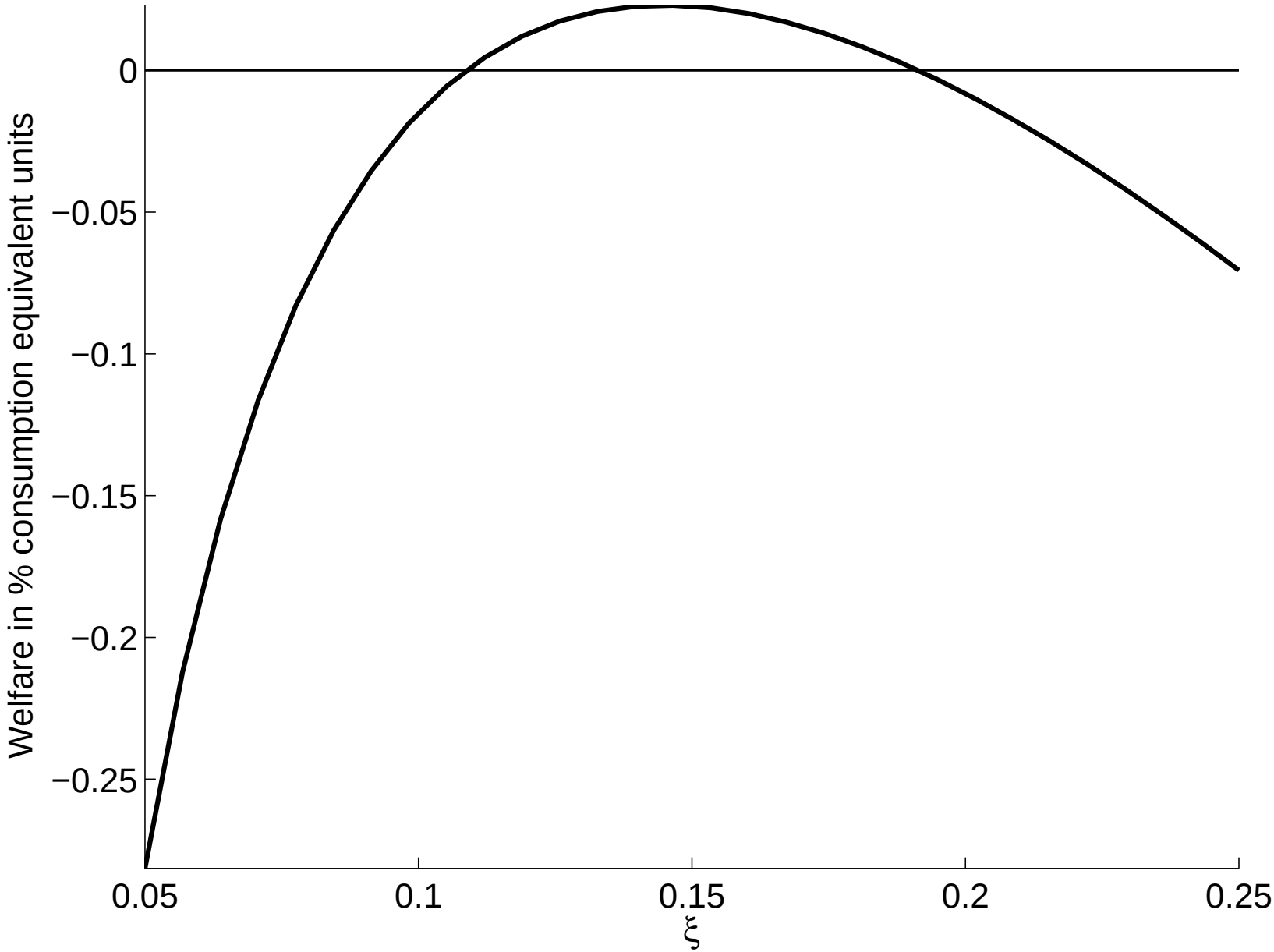
Welfare

- Compute the optimal capital requirement
  - use local approximation methods
  - simulate economy under benchmark tier-1-equity/risky asset and under new requirements
  - compute value function of households
- Welfare as a function of capital requirements

Optimal $\xi = 14\%$

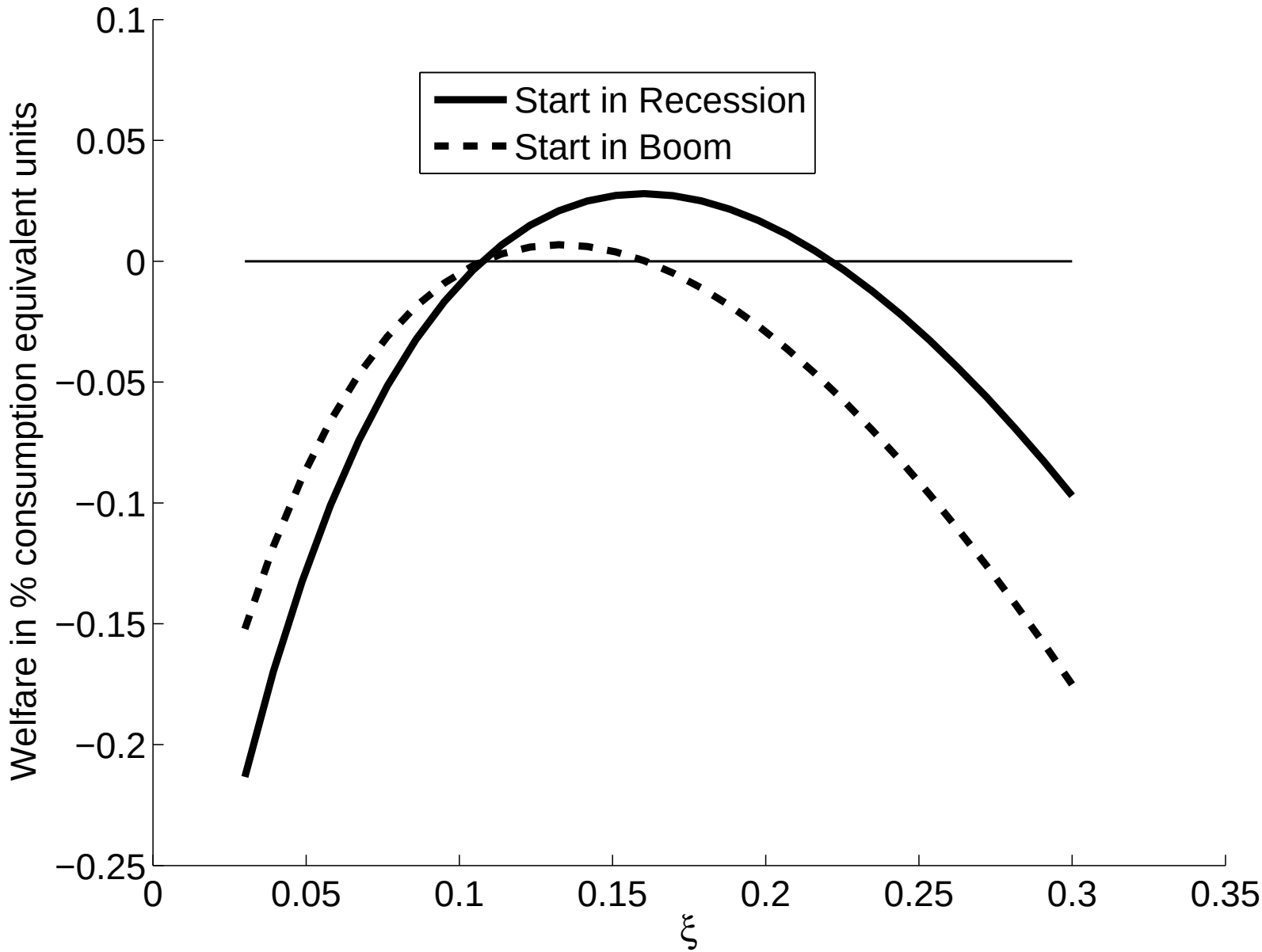


Reduction in funding costs

$$\underbrace{1+v\frac{y^h}{k^h}-\delta^h+\frac{TR}{k^h}\left(1+\omega_1\left(1-v\right)\frac{y^h}{k^h}\right)}_{\textit{Benefit of } k^h}=\underbrace{\xi\left(1+r^e\right)+\left(1-\xi\right)\left(1+r\right)}_{\textit{Funding costs of } k^h}$$

- Benchmark: k^h costs 2.57% with $r=1.5\%$ and $r^e=10\%$
- Increase requirement to 14%
  $\rightarrow$ With fixed prices, cost would increase by 10%
  $\rightarrow$ Reduction in debt reduces r to 0.88%
  $\rightarrow$ Overall funding costs fall by 16% to 2.15%
- Fall in funding costs $\rightarrow$ banks increase k^h by 2%

Raising capital requirement during crisis or boom?



Conclusion

- Mechanism:
  Higher capital requirement can lead to more lending when bank debt is valued for being safe and liquid
- Optimal capital requirement about $\xi = 14\%$
- Caveat: potential for safe asset substitution from shadow banks may mitigate channel

Thank you

Subsidy to banks

- Capture effects of guarantees on banks' liabilities
  - Assume: government cannot commit to not bailout banks
  - Guarantees subsidize leverage and risk-taking
- Unlimited liability and explicit subsidy

$$TR_t = \omega_3 \underbrace{k^h_{t-1}}_{\text{size}} \exp\left(-\omega_1 \underbrace{\frac{e_{t-1}+\pi_t}{k^h_{t-1}}}_{\text{capitalization}} + \omega_2 \underbrace{\sigma^h_t}_{\text{risk-taking}} \right)$$

$\omega_1, \omega_2, \omega_3 > 0$

- Implies complementarity between leverage and risk-taking

Back

Key parameters (ctd)

Par.	Governs	Target Moment	Value
ϕ_2	risk-return trade-off strength of $\downarrow \sigma^h \& \uparrow k^h$ to $\uparrow \xi$	vol(inc/risky-assets)	0.89
ω_2	risk-taking due to subsidy strength of $\downarrow \sigma^h$ to $\uparrow \xi$	$\text{Var}\left(\log\left(y_t^h/k_t^h\right) \mid \log \pi_{t-1}\right)$	2.92