Bank Capital Requirements: A Quantitative Analysis

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Motivation

- Key regulatory reform: Bank capital requirements

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- Policymakers: Strong consensus for higher bank capital requirements

Motivation

- In 2010, the Basel Committee on Banking Supervision: Raised Tier 1 capital requirement from 4 to 6 percent
  - Tier 1 $\rightarrow$ common stock $+$ retained earnings
- In July 2013, the Fed adopted the same Tier 1 capital requirement for all U.S. banks.

Motivation

The Ben S. Bernanke on regulatory capital framework:

"*[T]his framework requires banking organizations to hold more and higher quality capital, which acts as a financial* **cushion to absorb losses**, *while* **reducing the incentive for ... [banks] to take excessive risks**."

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- Is imposing higher bank capital requirements beneficial?

Question

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  - Banks risk-shift due to government bailouts.
  - Banking regulation
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- Dynamic banking sector
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  - Banking regulation
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- Endogenous growth
  - Concerns about growth
  - Funding for investment comes through banks
    $\rightarrow$ regulating banks affects investment and hence growth

Outline of the model

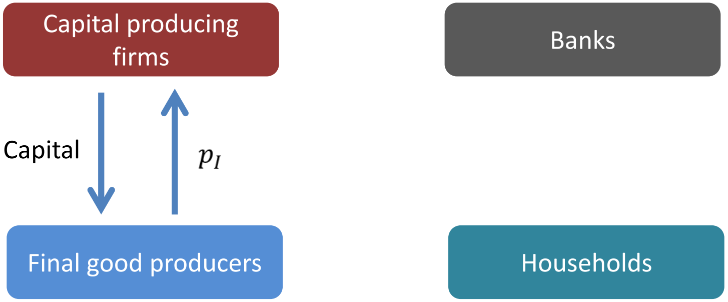
Capital producing firms

Banks

Final good producers

Households

Outline of the model



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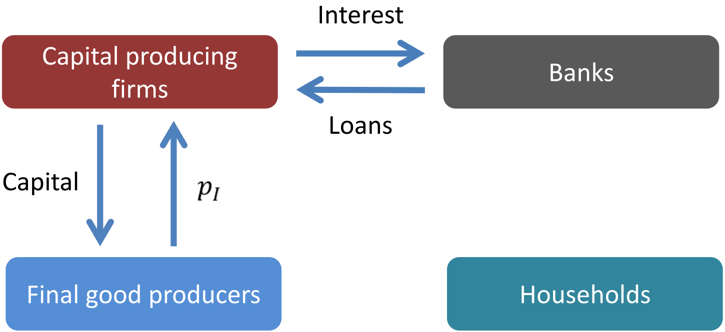

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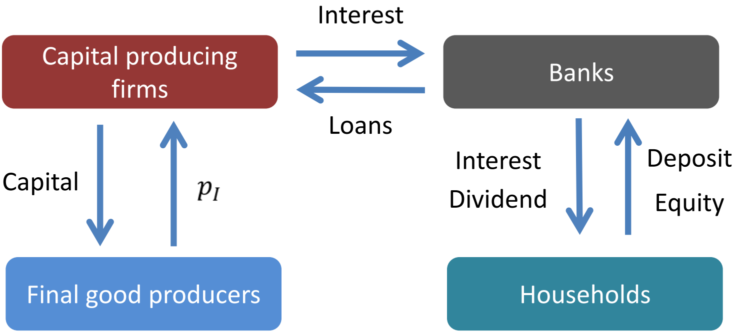

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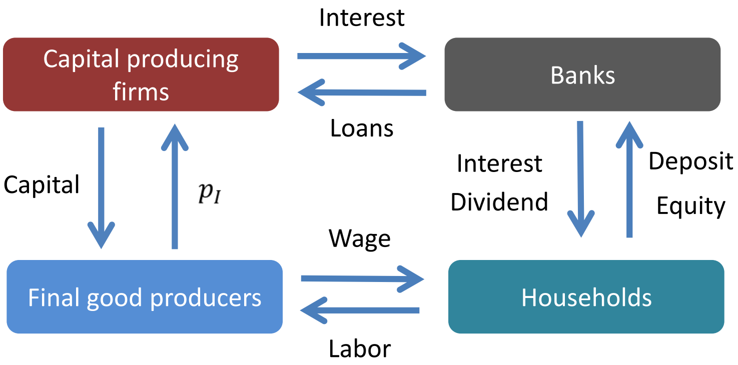

Households

- Representative household

$$U_0 = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{C_t^{1-1/\psi} - 1}{1 - 1/\psi}$$

- Endowed with 1 unit of labor $\rightarrow$ supply inelastically

Capital-producing firms (j = island, f = firm)

- Large number of islands indexed by j: state or industry
- Firms are **short-lived**
- i_t: required **investment today** for **production tomorrow**

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$$\text{capital produced tomorrow} = z_{j,t+1} \cdot \epsilon_{jf,t+1} \cdot i_t$$

$$\log \epsilon_{jft} \sim \mathcal{N}\left(-\mu - \frac{1}{2}\sigma_\epsilon^2, \sigma_\epsilon\right) \quad \forall j, f, t$$

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- Compactly

$$z_{j,t+1} \cdot [\chi \epsilon_{jf,t+1} + (1-\chi)] \cdot i_t$$

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- Small operating cost $= o \cdot i_t$
  $\rightarrow$ internal fund
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- Firm's default cutoff: $\bar{z}_{t+1}(z_t, \chi, \epsilon_{f,t+1})$

Road map

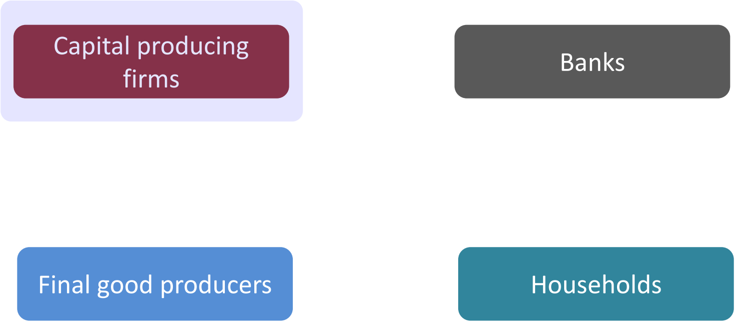
Capital producing firms

Banks

Final good producers

Households

Road map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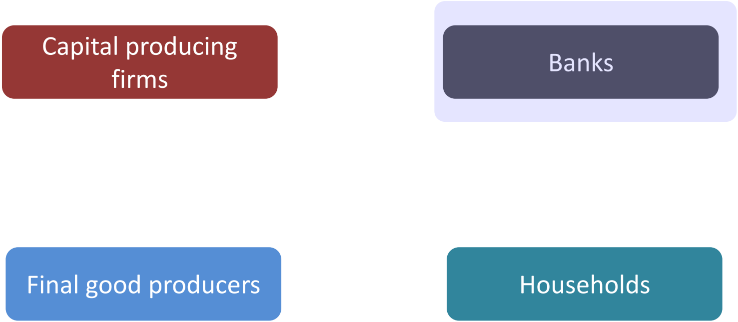
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Banks

- Each bank chooses one firm to finance

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- Bank's **net cash** at the **beginning of next period**

$$\pi_{t+1}(\chi_t, z_t, z_{t+1}, \epsilon_{f,t+1}) = i_t \Big[R^l(\chi_t, z_t) \cdot \mathbb{1}_{\{z_{t+1} \geq \bar{z}_{t+1}\}} + \overbrace{\eta \cdot p^I_{t+1} z_{t+1} [\chi_t \epsilon_{f,t+1} + (1-\chi_t)]}^{\text{Liquidated asset value}} \cdot \mathbb{1}_{\{z_{t+1} < \bar{z}_{t+1}\}} \Big] - \underbrace{R^b_{t+1} b_{t+1}}_{\text{Deposit liability}}$$

- Recovery rate η

Banks

- Bank monitoring cost: m per unit of investment
- d_t: net equity payout

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- Net distribution to bank shareholders:

$$d_t - \underbrace{\Phi(d_t)}_{\text{Equity issuance cost}}$$

Bank equity valuation

Bank's problem

$$V(z_t, \pi_t) = \max\{0, \quad \pi_t, \quad \max_{b_{t+1}, \chi_t, d_t} d_t - \Phi(d_t) + \mathbb{E}_t M_{t+1} V(z_{t+1}, \pi_{t+1})\}$$

subject to the **budget constraint** and **loan demand**

Three cases: (1) Default, (2) Exit but not default, and (3) Operate

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Three cases: (1) Default, (2) Exit but not default, and (3) Operate

and the **capital requirement** constraint

$$\frac{\overbrace{\pi_t - m \cdot i_t}^{\text{Retained earnings}} \quad - \quad \overbrace{d_t}^{\text{Equity payout}}}{i_t} \geq \bar{e}$$

Bank deposit valuation

- Bank default: bailed out with probability λ
- Bailouts are financed with lump sum taxes
- If not bailed out, recovery rate θ

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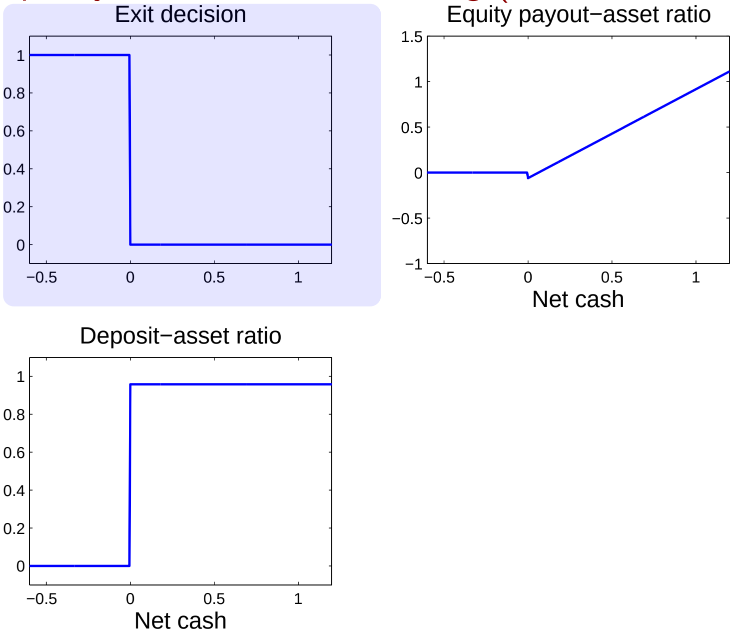
- Bank default: bailed out with probability λ
- Bailouts are financed with lump sum taxes
- If not bailed out, recovery rate θ
- Required return for depositors, $R^b_{t+1}(z_t, \pi_t)$, satisfies the condition

$$b_{t+1} = \mathbb{E}_t M_{t+1} \left[\overbrace{R^b_{t+1} b_{t+1} \cdot \mathbb{1}_{\{V_{t+1}>0\}}}^{\text{Bank not default}} + \overbrace{\lambda R^b_{t+1} b_{t+1} \cdot \mathbb{1}_{\{V_{t+1}=0\}}}^{\text{Bank default–bail out}} + \underbrace{(1-\lambda)\theta \cdot \text{Revenue}_{t+1} \cdot \mathbb{1}_{\{V_{t+1}=0\}}}_{\text{Bank default–not bail out}} \right]$$

Bank's policy functions: Risk-shifting (on one industry/z_j)



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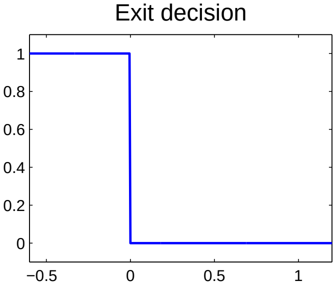

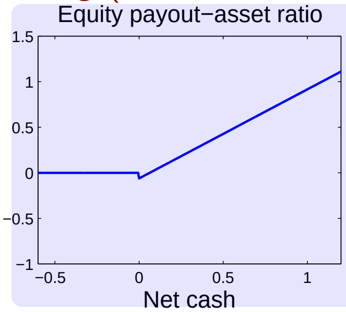

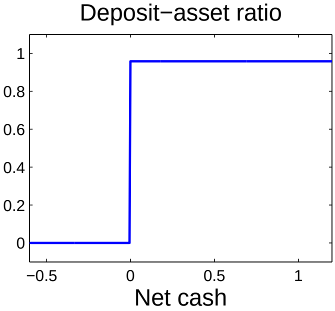

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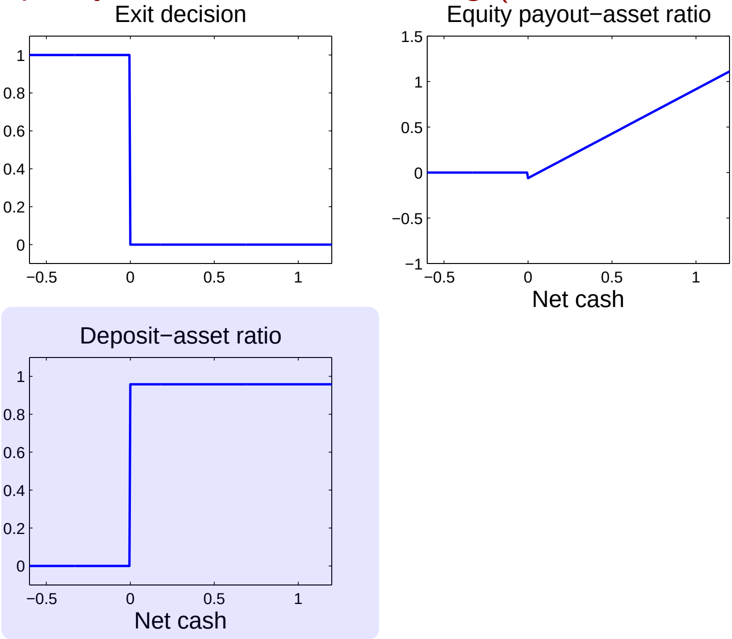

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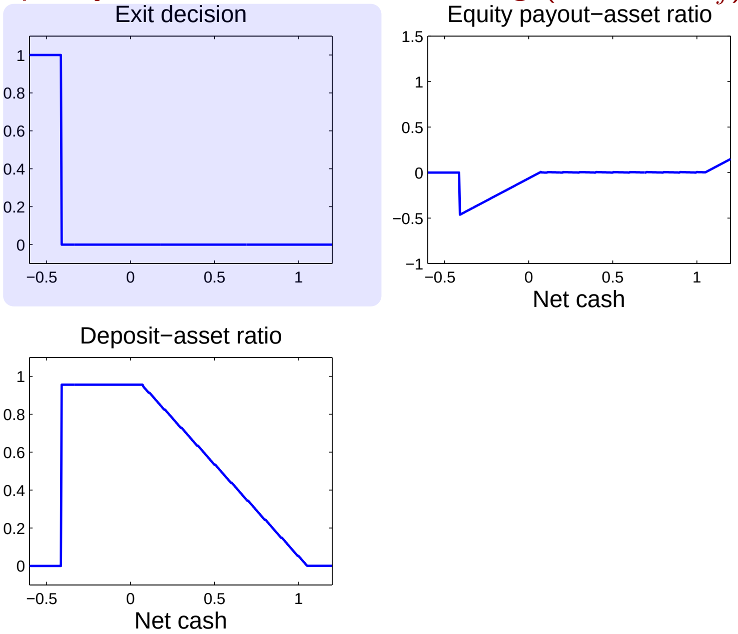

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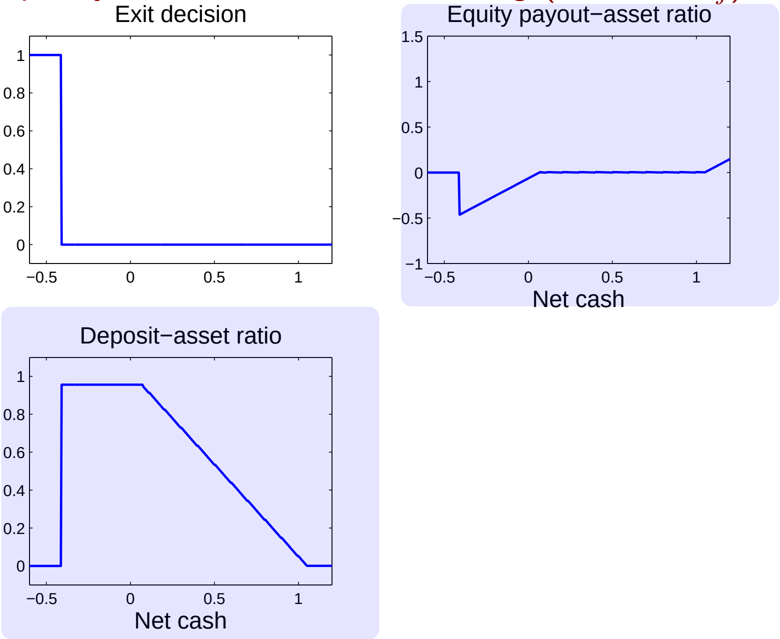

Distribution of banks

- Banks are heterogeneous only in terms of their idiosyncratic shocks and net cash:

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- Bank entry cost: $e \cdot i_t$

$$e \cdot i_t \leq \mathbb{E}_z V_t(z_t, \pi_t = 0)$$

- If bailed out, banks can continue to operate with $\pi_t = 0$

Equilibrium capital production

- Capital produced next period

$$I^s_{t+1} = i_t \int \int z_{t+1}[\chi_t \epsilon_{f,t+1} + (1-\chi_t)] \cdot \text{(Adjustments due to bankruptcies)} \times dP(\epsilon_{t+1}|z_{t+1}, \pi_{t+1}) \mathcal{B}_{t+1} d\Gamma_{t+1}$$

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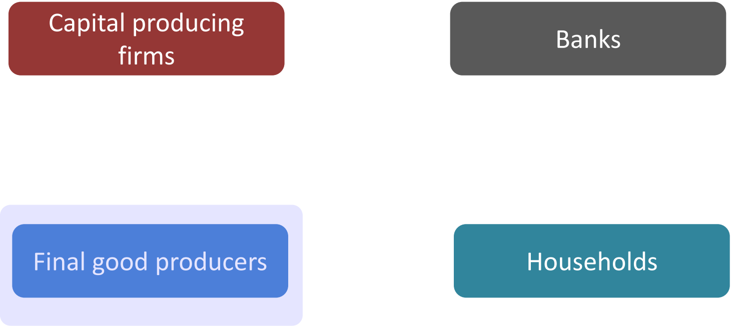
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Final good producer

- A measure one of final good producers indexed by $u \in [0, 1]$
- Technology

$$y_{ut} = A_t k_{ut}^{\alpha} (K_t l_{ut})^{1-\alpha}$$

Final good producer

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- Investment demand i_{ut}^d
- Investment adjustment cost

$$\frac{a}{2} \left(\frac{i_{ut}^d}{k_{u,t-1}} \right)^2 k_{u,t-1}$$

Equilibrium Growth

- Aggregate output

$$Y_t = A_t K_t$$

- Growth

$$\frac{Y_{t+1}}{Y_t} = \frac{A_{t+1}}{A_t}\frac{K_{t+1}}{K_t}$$

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$$\frac{Y_{t+1}}{Y_t} = \frac{A_{t+1}}{A_t} \frac{K_{t+1}}{K_t}$$

- Aggregate capital accumulation

$$K_t = (1-\delta)K_{t-1} + I_t^d$$

- Capital market clearing

$$\int_0^1 i_{ut}^d du = I_t^d = I_t^s$$

Quantitative Assessment

- Calibrate the model to U.S. regulation: $\bar{e} = .04$
  $\rightarrow$ Benchmark
- Welfare calculations are relative to this benchmark

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- Period = quarter
- No aggregate uncertainty

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Description	Symbol	Value	Source/Target
TFP level	A	0.11	Match consumption growth

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Subjective discount factor	β	0.987	Cooley and Prescott (1995)
Income share of capital	α	0.45	Cooley and Prescott (1995)
Capital depreciation rate	δ	0.025	Jermann and Quadrini (2012)
Intertemporal elasticity of substitution	ψ	1.1	Bansal, Kiku, and Yaron (2013)
Loan recovery parameter	η	0.8	Gomes and Schmid (2010)

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Investment adjustment cost	a	5	Gilchrist and Himmelberg (1995)
Monitoring cost	m	0.02	Philippon (2012)

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Investment adjustment cost	a	5	Gilchrist and Himmelberg (1995)
Monitoring cost	m	0.02	Philippon (2012)
Bank deposit recovery parameter	θ	0.7	James (1991)
Equity issuance marginal cost	ϕ	0.025	Gomes (2001)
Probability of bailout	λ	0.9	Koetter and Noth (2012)

- Equity issuance cost: $\Phi(d) = -\phi \cdot d \cdot \mathbb{1}_{\{d<0\}}$

Calibration

Description	Symbol	Value	Target
Firm's operating cost	o	0.023	Average return on loans
Standard deviation of ϵ	σ_ϵ	0.363	x-std return on loans
Bank entry cost	e	0.06	Exit rate
Reduction in productivity of risky firm	μ	0.02	Average net interest margin
Persistence of island specific shock	ρ_z	0.95	x-std net interest margin
Volatility of island specific shock	σ_z	0.011	Default

$$\log z_{t+1} = \rho_z \log z_t + \sigma_z \epsilon_{z,t+1}$$

Main Statistics

Macro moments			Data	Model ($\bar{e} = .04$)
		Δc	0.49	
		c/y	0.76	
Bank moments		Data		
	Top 1%	Top 5%	Top 10%	
Targeted moments				
Return on loan				
mean	4.33	4.63	4.92	
x-std	2.95	3.51	3.99	
Net interest margin				
mean	2.89	3.18	3.43	
x-std	3.05	3.55	4.03	
Failure	0.33	0.29	0.28	
Exit rate	1.02	1.17	1.20	
Other moments				
Net charge-off rate				
mean	2.70	0.93	0.76	
x-std	17.94	13.74	11.00	
Fraction risk-shifting				
Leverage ratio	7.74	8.29	8.51	
Tier 1 capital ratio	10.25	12.18	12.62	
Number of banks	113	564	1129	

Source: Call Reports 1984-2010. Top x% column indicates statistics calculated from the top x% banks in term of total assets. 'mean' is the time-series average of cross-sectional, and 'x-std' is the time-series average of cross-sectional standard deviation.

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		Δc	0.49	0.49
		c/y	0.76	0.69
Bank moments	Data			
	Top 1%	Top 5%	Top 10%	
Targeted moments				
Return on loan				
mean	4.33	4.63	4.92	4.01
x-std	2.95	3.51	3.99	5.23
Net interest margin				
mean	2.89	3.18	3.43	1.95
x-std	3.05	3.55	4.03	6.09
Failure	0.33	0.29	0.28	1.07
Exit rate	1.02	1.17	1.20	4.27
Other moments				
Net charge-off rate				
mean	2.70	0.93	0.76	2.86
x-std	17.94	13.74	11.00	10.09
Fraction risk-shifting				4.14
Leverage ratio	7.74	8.29	8.51	11.63
Tier 1 capital ratio	10.25	12.18	12.62	11.63
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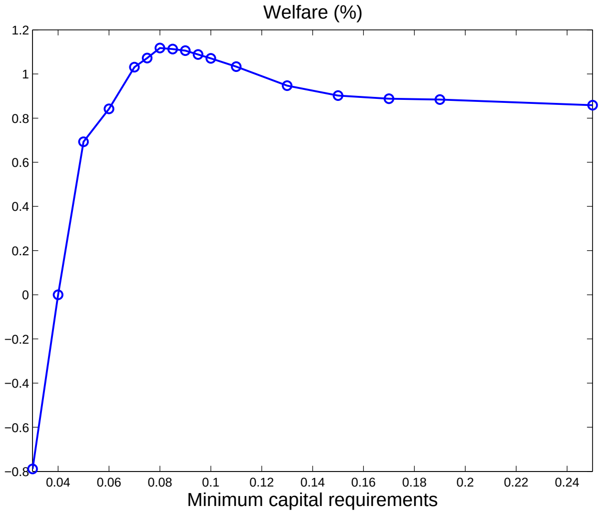
Welfare implications

Let c_t be the consumption-capital ratio

$$C_t = c_t K_{t-1} = \Delta k^{t-1} \cdot \underbrace{c \cdot K_0}_{\text{Initial level}}$$

Welfare implications



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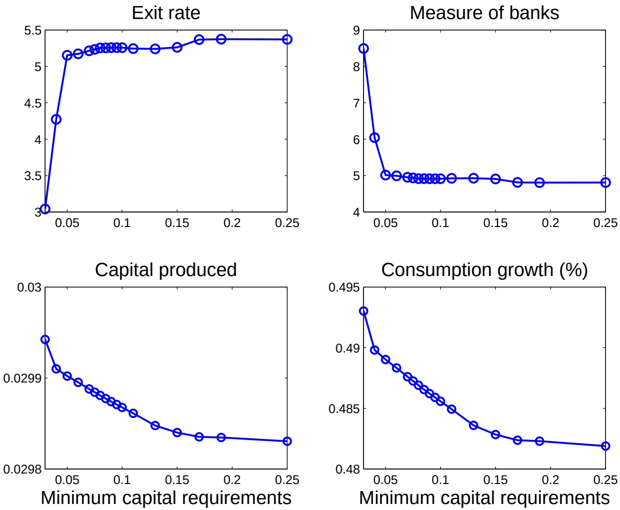

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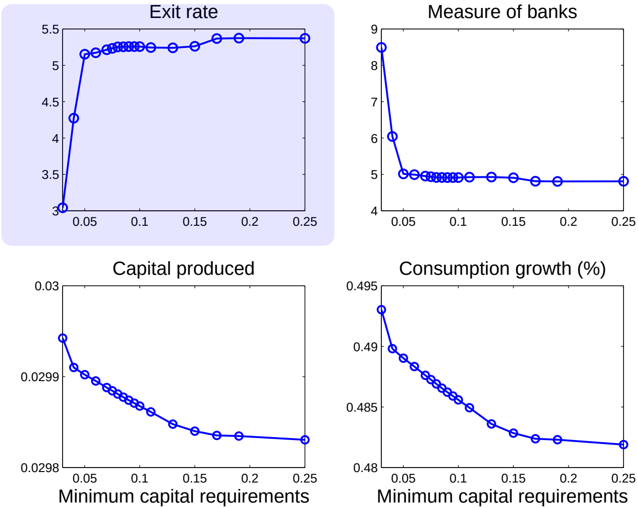

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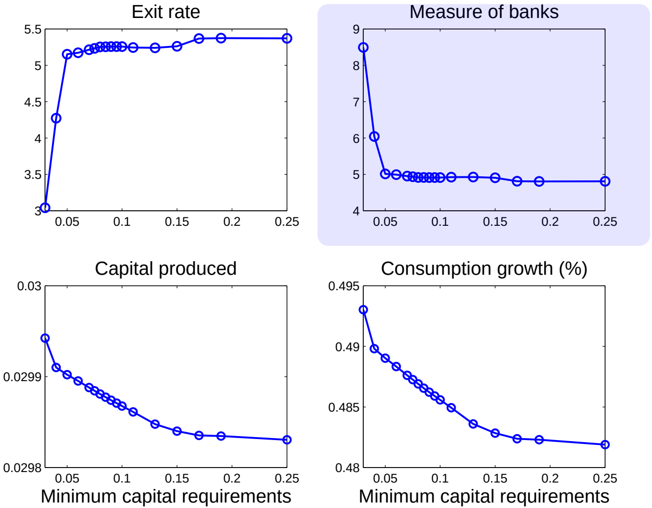

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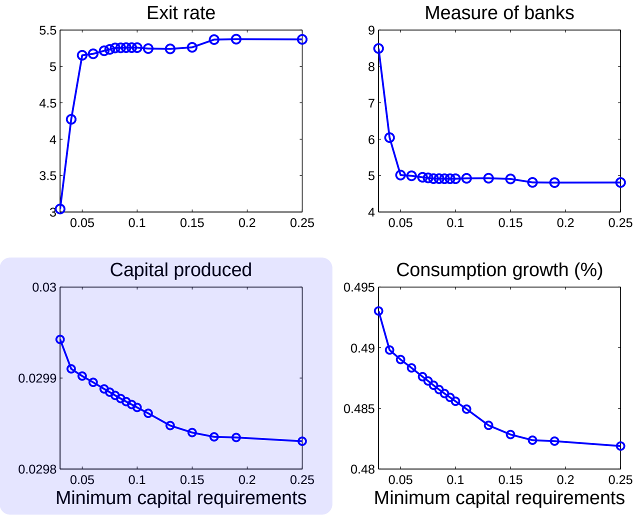

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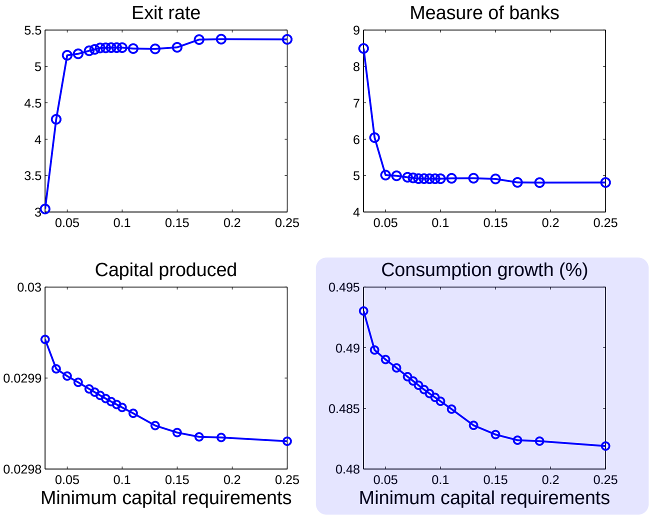

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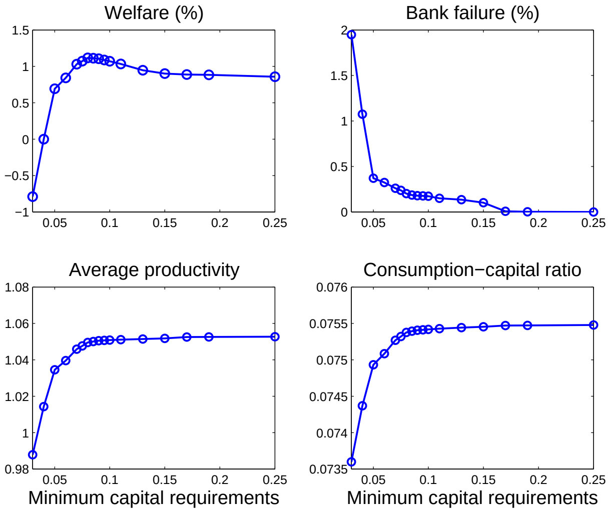

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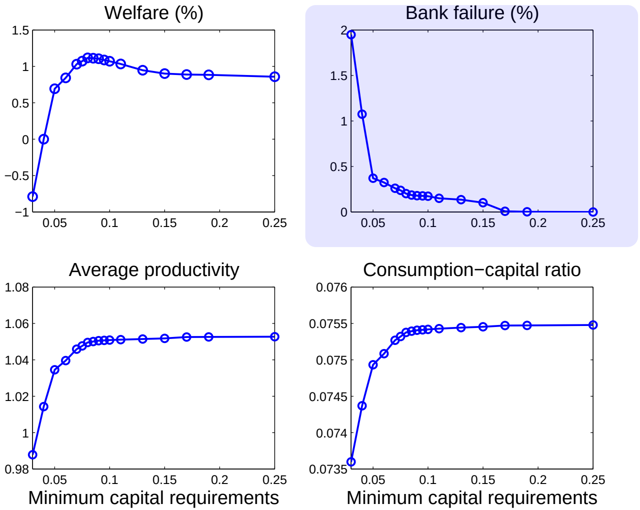

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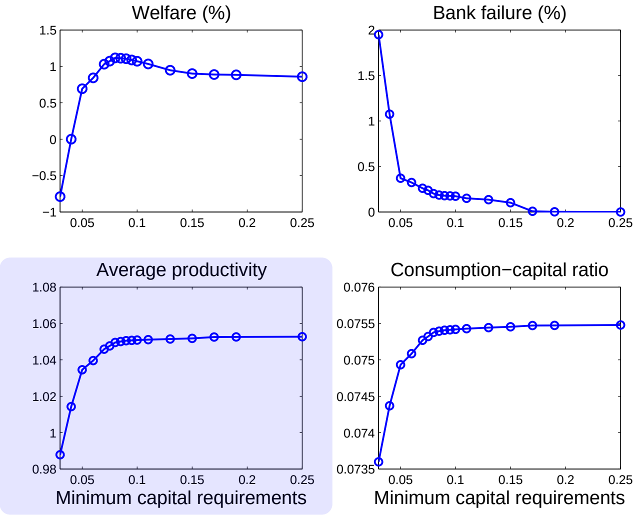

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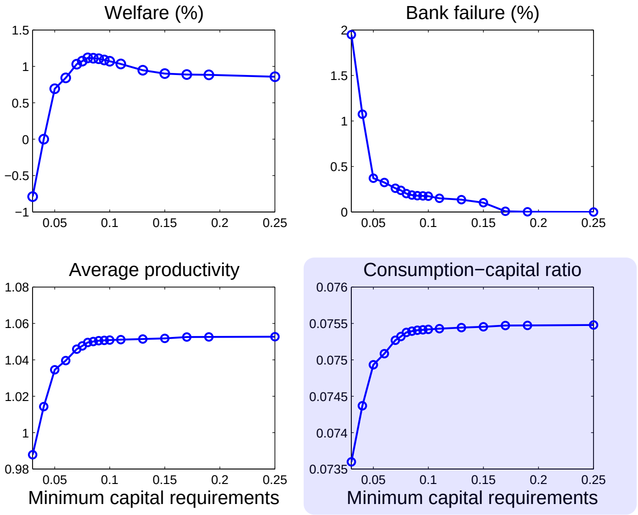
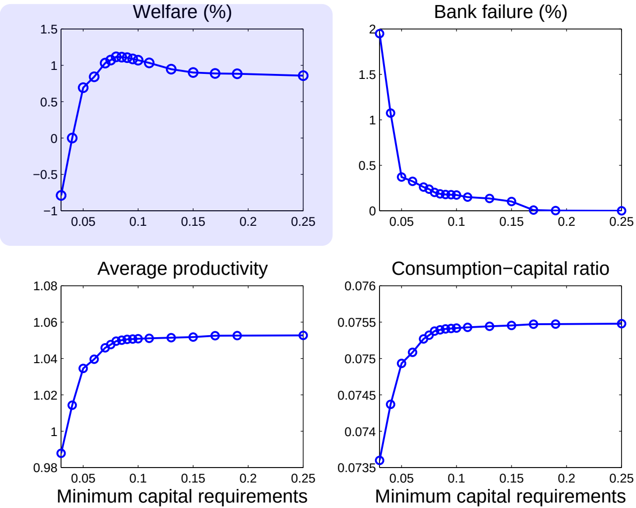


Welfare implications



Welfare implications

Why welfare decreases after 8 percent?

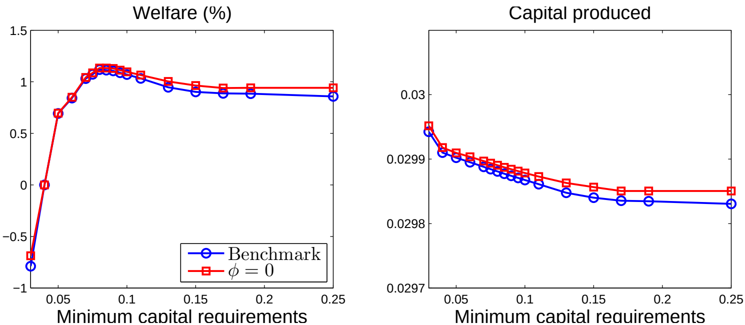
1. Romer "learning-by-doing" externality

Welfare implications

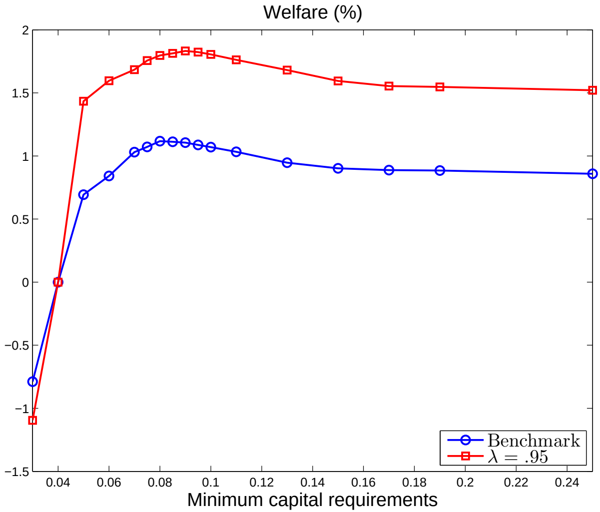
Why welfare decreases after 8 percent?

1. Romer “learning-by-doing” externality
2. Equity issuance cost

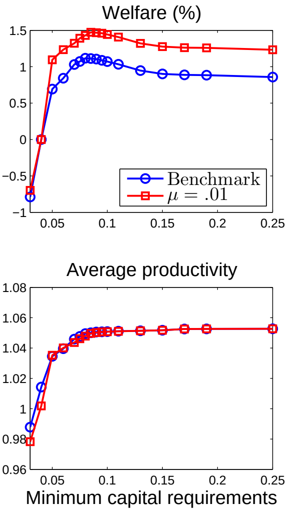
Role of equity issuance cost: ϕ



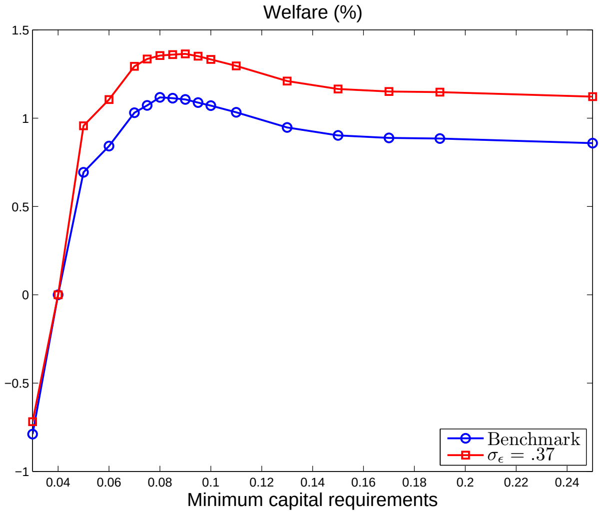
Role of probability of bailout: λ



Role of productivity loss due to risk-shifting: μ



Role of additional risk exposure due to risk-shifting: σ_ϵ



Conclusion

- Dynamic general equilibrium banking model
- The calibrated version of the model suggests an 8% minimum Tier 1 capital requirement
  $\rightarrow$ significant welfare improvement: 1.1% of lifetime consumption
- Punch-line: Optimal level is **higher** than in both Basel II and Basel III
- Broader level: The need to re-examine current bank capital regulations