Bank Capital Requirements: A Quantitative Analysis

Thiên T. Nguyễn
The Wharton School, University of Pennsylvania
Motivation

- Key regulatory reform: Bank capital requirements
Motivation

- Key regulatory reform: Bank capital requirements
- 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 → common stock + retained earnings

- In July 2013, the Fed adopted the same Tier 1 capital requirement for all U.S. banks.
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.”
Motivation

▶ “Do new bank-capital requirements pose a risk to growth?”
– The Economist, 8/20/2010
Motivation

▶ “Do new bank-capital requirements pose a risk to growth?”
  –The Economist, 8/20/2010

▶ Is imposing higher bank capital requirements beneficial?
Question

- What are the welfare implications of bank capital requirements?
Question

▶ What are the welfare implications of bank capital requirements?
▶ I propose a general equilibrium banking model to study this question.
What are the welfare implications of bank capital requirements? I propose a general equilibrium banking model to study this question.

In this paper, bank capital affects growth and risk:

- Dynamic banking sector
  - Banks risk-shift due to government bailouts.
  - Banking regulation
    → reduces risk-shifting incentive, fostering growth
What are the welfare implications of bank capital requirements?

I propose a general equilibrium banking model to study this question.

In this paper, bank capital affects growth and risk:

- Dynamic banking sector
  - Banks risk-shift due to government bailouts.
  - Banking regulation
    - Reduces risk-shifting incentive, fostering growth

- Endogenous growth
  - Concerns about growth
  - Funding for investment comes through banks
    - Regulating banks affects investment and hence growth
My contribution

- **Focus**: bank risk-shifting due to bailouts
  → highlighted in *theoretical* banking literature

- **First step** to push the policy debate toward a more *quantitative* discussion
  → provide a coherent way to quantitatively think about optimal bank requirement
Outline of the model

- Capital producing firms
- Banks
- Final good producers
- Households
Outline of the model

- Capital producing firms
- Final good producers
- Banks
- Households

$P_I$
Outline of the model

Capital producing firms

Final good producers

$\pi_I$

Interest

Loans

Banks

Households

Capital
Outline of the model

- **Capital producing firms**
  - Capital
  - $p_I$
  - Final good producers

- **Banks**
  - Interest
  - Loans
  - Interest
  - Dividend
  - Deposit
  - Equity

- **Households**
Outline of the model

- **Capital producing firms**
  - Capital
  - $p_I$
  - Final good producers

- **Banks**
  - Loans
  - Interest
  - Deposit
  - Equity
  - Dividend

- **Households**
  - Wage
  - Labor
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 → supply inelastically**
Capital-producing firms ($j = \text{island}, \ f = \text{firm}$)

- Large number of islands indexed by $j$: state or industry
- Firms are short-lived
- $i_t$: required investment today for production tomorrow
Capital-producing firms \((j = \text{island}, \ f = \text{firm})\)

- Large number of islands indexed by \(j\): state or industry
- Firms are **short-lived**
- \(i_t\): required **investment today** for **production tomorrow**
- Two types of firms
  - Normal firm
    
    \[
    \text{capital produced tomorrow} = z_{j,t+1} \cdot i_t
    \]
Capital-producing firms \((j = \text{island}, f = \text{firm})\)

- Large number of islands indexed by \(j\): state or industry
- Firms are **short-lived**
- \(i_t\): required **investment today** for **production tomorrow**
- Two types of firms
  - Normal firm
    \[
    \text{capital produced tomorrow} = z_{j,t+1} \cdot i_t
    \]
  - Risky-low-productivity firm
    \[
    \text{capital produced tomorrow} = z_{j,t+1} \cdot \epsilon_{j,f,t+1} \cdot i_t
    \]
    \[
    \log \epsilon_{j,f,t} \sim \mathcal{N} \left( -\mu - \frac{1}{2} \sigma_\epsilon^2, \sigma_\epsilon \right) \quad \forall j, f, t
    \]
Capital-producing firms \((j = \text{island}, f = \text{firm})\)

- Large number of islands indexed by \(j\): state or industry
- Firms are **short-lived**
- \(i_t\): required **investment today** for **production tomorrow**
- Two types of firms
  - Normal firm
    \[
    \text{capital produced tomorrow} = z_{j,t+1} \cdot i_t
    \]
  - Risky-low-productivity firm
    \[
    \text{capital produced tomorrow} = z_{j,t+1} \cdot \epsilon_{j,f,t+1} \cdot i_t
    \]
    \[
    \log \epsilon_{j,f,t} \sim \mathcal{N} \left( -\mu - \frac{1}{2} \sigma^2, \sigma \right) \quad \forall j, f, t
    \]
  - Compactly
    \[
    z_{j,t+1} \cdot [\chi \epsilon_{j,f,t+1} + (1 - \chi)] \cdot i_t
    \]
Capital-producing firms

- **Small operating cost** = \( o \cdot i_t \)
  \( \rightarrow \) internal fund

- **Funding need from bank** \( i_t \)
Capital-producing firms

- Small operating cost = \( o \cdot i_t \) → internal fund
- Funding need from bank \( i_t \)
- Net income tomorrow =

\[
\underbrace{p^I_{t+1} z_{t+1} \cdot [\chi \epsilon_{f,t+1} + (1 - \chi)] \cdot i_t}_{\text{Revenue}} - \underbrace{R^l(\chi, z_t) \cdot i_t}_{\text{Debt repayment}}
\]
Capital-producing firms

- Small operating cost = $o \cdot i_t$
  $\rightarrow$ internal fund

- Funding need from bank $i_t$

- Net income tomorrow =
  \[
  p^I_{t+1} z_{t+1} \cdot [\chi \epsilon_{f,t+1} + (1 - \chi)] \cdot i_t - R^I(\chi, z_t) \cdot i_t
  \]
  \[
  \text{Revenue} - \text{Debt repayment}
  \]

- Zero-profit condition
  \[
  \mathbb{E}_t M_{t+1} \max\{0, \text{Net income tomorrow}\} = \text{Current operating cost}
  \]
Capital-producing firms

- Small operating cost = \( o \cdot i_t \)
  \( \rightarrow \) internal fund

- Funding need from bank \( i_t \)

- Net income tomorrow =
  \[
  p^I_{t+1} z_{t+1} \cdot [\chi \epsilon f, t + 1 + (1 - \chi)] \cdot i_t - R^l(\chi, z_t) \cdot i_t
  \]

  Revenue - Debt repayment

- Zero-profit condition

  Default option
  \[
  E_t M_{t+1} \max\{0, \text{Net income tomorrow}\} = \text{Current operating cost}
  \]

- 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

- Capital producing firms
- Banks
- Final good producers
- Households
Road map

- Capital producing firms
- Final good producers
- Banks
- Households
Banks

- Each bank chooses one firm to finance
Banks

- Each bank chooses one firm to finance
- Bank’s net cash at the beginning of next period

\[ \pi_{t+1}(X_t, z_t, z_{t+1}, \epsilon_{f,t+1}) = i_t \left[ R_l^l(X_t, z_t) \cdot \mathbb{1}\{z_{t+1} \geq \bar{z}_{t+1}\} \right. \]

\[ \text{Liquidated asset value} \]

\[ + \eta \cdot p_{t+1}^l z_{t+1} [X_t \epsilon_{f,t+1} + (1 - X_t)] \cdot \mathbb{1}\{z_{t+1} < \bar{z}_{t+1}\} \]

\[ - R_{t+1}^b b_{t+1} \]

Deposits liability

- Recovery rate \( \eta \)
Banks

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

- Bank monitoring cost: \( m \) per unit of investment
- \( d_t \): net equity payout
- Bank’s budget constraint

\[ \pi_t - m \cdot i_t + b_{t+1} = i_t + d_t \]

- Current net cash
- Monitoring cost
- Lending

\( \Phi \): Equity issuance cost
Banks

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

- Bank’s budget constraint

$$
\pi_t - m \cdot i_t + b_{t+1} = i_t + d_t
$$

- Current net cash
- Monitoring cost
- Lending

- Net distribution to bank shareholders:

$$
d_t - \Phi(d_t)
$$

- Equity issuance cost
Bank equity valuation

Bank’s problem

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

subject to the budget constraint and loan demand

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

Bank’s problem

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

subject to the budget constraint and loan demand

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

and the capital requirement constraint

\[ \frac{\text{Retained earnings}}{\pi_t - m \cdot i_t} - \frac{\text{Equity payout}}{d_t} \geq \bar{e} \]
Bank deposit valuation

- Bank default: bailed out with probability $\lambda$
- Bailouts are financed with lump sum taxes
- If not bailed out, recovery rate $\theta$
Bank deposit valuation

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

\[
B_{t+1} = E_t M_{t+1} = \begin{cases} 
R^b_{t+1} b_{t+1} \cdot 1_{\{V_{t+1} > 0\}} + \lambda R^b_{t+1} b_{t+1} \cdot 1_{\{V_{t+1} = 0\}} \\
+ (1 - \lambda) \theta \cdot \text{Revenue}_{t+1} \cdot 1_{\{V_{t+1} = 0\}} \\
\end{cases}
\]

Bank default–not bail out
Bank’s policy functions: Risk-shifting (on one industry $z_j$)

<table>
<thead>
<tr>
<th>Exit decision</th>
<th>Equity payout–asset ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net cash</td>
<td>Deposit–asset ratio</td>
</tr>
</tbody>
</table>

- Exit decision graph
- Equity payout–asset ratio graph
- Deposit–asset ratio graph
Bank’s policy functions: Risk-shifting (on one industry $z_j$)

**Exit decision**

**Equity payout–asset ratio**

**Deposit–asset ratio**
Bank’s policy functions: Risk-shifting (on one industry $\tilde{z}_j$)
Bank’s policy functions: No risk-shifting (different $z_j$)
Bank’s policy functions: No risk-shifting (different $z_j$)

Exit decision

Equity payout–asset ratio

Deposit–asset ratio

Net cash

Net cash
Distribution of banks

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

\[ B_t \cdot \Gamma(z_t, \pi_t) \]

\( B_t \) Mass \( \cdot \Gamma(z_t, \pi_t) \) cdf
Distribution of banks

- Banks are heterogeneous only in terms of their idiosyncratic shocks and net cash:
  \[ B_t \cdot \Gamma(z_t, \pi_t) \]
  Mass \( \cdot \) cdf

- 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

\[ I_{t+1}^s = i_t \int \int z_{t+1} [\chi t \epsilon f, t+1 + (1 - \chi t)] \cdot (\text{Adjustments due to bankruptcies}) \times dP(\epsilon_{t+1} | z_{t+1}, \pi_{t+1}) B_{t+1} d\Gamma_{t+1} \]
Road map

- Capital producing firms
- Banks
- Final good producers
- Households
Road map

- Capital producing firms
- Final good producers
- Banks
- Households
Road map

- Capital producing firms
- Banks
- Final good producers
- Households
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

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

\[
y_{ut} = A_t k_{ut}^\alpha (K t_l_{ut})^{1-\alpha}
\]

- Investment demand $i^d_{ut}$
- Investment adjustment cost

\[
\frac{a}{2} \left( \frac{i^d_{ut}}{k_{u,t-1}} \right)^2 k_{u,t-1}
\]
Equilibrium Growth

- Aggregate output

\[ Y_t = A_t K_t \]

- Growth

\[ \frac{Y_{t+1}}{Y_t} = \frac{A_{t+1}}{A_t} \frac{K_{t+1}}{K_t} \]
Equilibrium Growth

- **Aggregate output**

\[ Y_t = A_t K_t \]

- **Growth**

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

- **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: $\bar{e} = .04$
  → Benchmark

- Welfare calculations are relative to this benchmark
Calibration

- Period = quarter
- No aggregate uncertainty
Calibration

- Period = quarter
- No aggregate uncertainty

<table>
<thead>
<tr>
<th>Description</th>
<th>Symbol</th>
<th>Value</th>
<th>Source/Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>TFP level</td>
<td>$A$</td>
<td>0.11</td>
<td>Match consumption growth</td>
</tr>
</tbody>
</table>
Calibration

- Period = quarter
- No aggregate uncertainty

<table>
<thead>
<tr>
<th>Description</th>
<th>Symbol</th>
<th>Value</th>
<th>Source/Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>TFP level</td>
<td>$A$</td>
<td>0.11</td>
<td>Match consumption growth</td>
</tr>
<tr>
<td>Subjective discount factor</td>
<td>$\beta$</td>
<td>0.987</td>
<td>Cooley and Prescott (1995)</td>
</tr>
<tr>
<td>Income share of capital</td>
<td>$\alpha$</td>
<td>0.45</td>
<td>Cooley and Prescott (1995)</td>
</tr>
<tr>
<td>Capital depreciation rate</td>
<td>$\delta$</td>
<td>0.025</td>
<td>Jermann and Quadrini (2012)</td>
</tr>
<tr>
<td>Intertemporal elasticity of substitution</td>
<td>$\psi$</td>
<td>1.1</td>
<td>Bansal, Kiku, and Yaron (2013)</td>
</tr>
<tr>
<td>Loan recovery parameter</td>
<td>$\eta$</td>
<td>0.8</td>
<td>Gomes and Schmid (2010)</td>
</tr>
</tbody>
</table>
Calibration

- Period = quarter
- No aggregate uncertainty

<table>
<thead>
<tr>
<th>Description</th>
<th>Symbol</th>
<th>Value</th>
<th>Source/Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>TFP level</td>
<td>$A$</td>
<td>0.11</td>
<td>Match consumption growth</td>
</tr>
<tr>
<td>Subjective discount factor</td>
<td>$\beta$</td>
<td>0.987</td>
<td>Cooley and Prescott (1995)</td>
</tr>
<tr>
<td>Income share of capital</td>
<td>$\alpha$</td>
<td>0.45</td>
<td>Cooley and Prescott (1995)</td>
</tr>
<tr>
<td>Capital depreciation rate</td>
<td>$\delta$</td>
<td>0.025</td>
<td>Jermann and Quadrini (2012)</td>
</tr>
<tr>
<td>Intertemporal elasticity of substitution</td>
<td>$\psi$</td>
<td>1.1</td>
<td>Bansal, Kiku, and Yaron (2013)</td>
</tr>
<tr>
<td>Loan recovery parameter</td>
<td>$\eta$</td>
<td>0.8</td>
<td>Gomes and Schmid (2010)</td>
</tr>
<tr>
<td>Investment adjustment cost</td>
<td>$a$</td>
<td>5</td>
<td>Gilchrist and Himmelberg (1995)</td>
</tr>
<tr>
<td>Monitoring cost</td>
<td>$m$</td>
<td>0.02</td>
<td>Philippon (2012)</td>
</tr>
</tbody>
</table>
Calibration

- Period = quarter
- No aggregate uncertainty

<table>
<thead>
<tr>
<th>Description</th>
<th>Symbol</th>
<th>Value</th>
<th>Source/Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>TFP level</td>
<td>$A$</td>
<td>0.11</td>
<td>Match consumption growth</td>
</tr>
<tr>
<td>Subjective discount factor</td>
<td>$\beta$</td>
<td>0.987</td>
<td>Cooley and Prescott (1995)</td>
</tr>
<tr>
<td>Income share of capital</td>
<td>$\alpha$</td>
<td>0.45</td>
<td>Cooley and Prescott (1995)</td>
</tr>
<tr>
<td>Capital depreciation rate</td>
<td>$\delta$</td>
<td>0.025</td>
<td>Jermann and Quadrini (2012)</td>
</tr>
<tr>
<td>Intertemporal elasticity of substitution</td>
<td>$\psi$</td>
<td>1.1</td>
<td>Bansal, Kiku, and Yaron (2013)</td>
</tr>
<tr>
<td>Loan recovery parameter</td>
<td>$\eta$</td>
<td>0.8</td>
<td>Gomes and Schmid (2010)</td>
</tr>
<tr>
<td>Investment adjustment cost</td>
<td>$a$</td>
<td>5</td>
<td>Gilchrist and Himmelberg (1995)</td>
</tr>
<tr>
<td>Monitoring cost</td>
<td>$m$</td>
<td>0.02</td>
<td>Philippon (2012)</td>
</tr>
<tr>
<td>Bank deposit recovery parameter</td>
<td>$\theta$</td>
<td>0.7</td>
<td>James (1991)</td>
</tr>
<tr>
<td>Equity issuance marginal cost</td>
<td>$\phi$</td>
<td>0.025</td>
<td>Gomes (2001)</td>
</tr>
<tr>
<td>Probability of bailout</td>
<td>$\lambda$</td>
<td>0.9</td>
<td>Koetter and Noth (2012)</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Description</th>
<th>Symbol</th>
<th>Value</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firm’s operating cost</td>
<td>$o$</td>
<td>0.023</td>
<td>Average return on loans</td>
</tr>
<tr>
<td>Standard deviation of $\epsilon$</td>
<td>$\sigma_\epsilon$</td>
<td>0.363</td>
<td>x-std return on loans</td>
</tr>
<tr>
<td>Bank entry cost</td>
<td>$e$</td>
<td>0.06</td>
<td>Exit rate</td>
</tr>
<tr>
<td>Reduction in productivity of risky firm</td>
<td>$\mu$</td>
<td>0.02</td>
<td>Average net interest margin</td>
</tr>
<tr>
<td>Persistence of island specific shock</td>
<td>$\rho_z$</td>
<td>0.95</td>
<td>x-std net interest margin</td>
</tr>
<tr>
<td>Volatility of island specific shock</td>
<td>$\sigma_z$</td>
<td>0.011</td>
<td>Default</td>
</tr>
</tbody>
</table>

\[
\log z_{t+1} = \rho_z \log z_t + \sigma_z \epsilon_{z,t+1}
\]
## Main Statistics

<table>
<thead>
<tr>
<th>Macro moments</th>
<th>Data</th>
<th>Model ($\bar{e} = .04$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\Delta c$</td>
<td>0.49</td>
</tr>
<tr>
<td></td>
<td>$c/y$</td>
<td>0.76</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bank moments</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Top 1%</td>
</tr>
<tr>
<td>Targeted moments</td>
<td></td>
</tr>
<tr>
<td>Return on loan</td>
<td>mean</td>
</tr>
<tr>
<td></td>
<td>x-std</td>
</tr>
<tr>
<td>Net interest margin</td>
<td>mean</td>
</tr>
<tr>
<td></td>
<td>x-std</td>
</tr>
<tr>
<td>Failure</td>
<td>0.33</td>
</tr>
<tr>
<td>Exit rate</td>
<td>1.02</td>
</tr>
</tbody>
</table>

| 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.
# Main Statistics

<table>
<thead>
<tr>
<th>Macro moments</th>
<th>Data</th>
<th>Model ($\bar{e} = .04$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta c$</td>
<td>0.49</td>
<td>0.49</td>
</tr>
<tr>
<td>$c/y$</td>
<td>0.76</td>
<td>0.69</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bank moments</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Top 1%</td>
</tr>
<tr>
<td>Targeted moments</td>
<td></td>
</tr>
<tr>
<td>Return on loan</td>
<td>mean 4.33</td>
</tr>
<tr>
<td></td>
<td>x-std 2.95</td>
</tr>
<tr>
<td>Net interest margin</td>
<td></td>
</tr>
<tr>
<td>mean 2.89</td>
<td>3.18</td>
</tr>
<tr>
<td>x-std 3.05</td>
<td>3.55</td>
</tr>
<tr>
<td>Failure</td>
<td>0.33</td>
</tr>
<tr>
<td>Exit rate</td>
<td>1.02</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Other moments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net charge-off rate</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Fraction risk-shifting</td>
</tr>
<tr>
<td>Leverage ratio</td>
</tr>
<tr>
<td>Tier 1 capital ratio</td>
</tr>
<tr>
<td>Number of banks</td>
</tr>
</tbody>
</table>

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.
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

![Graph showing the relationship between minimum capital requirements and welfare percentage]
Welfare implications

- **Exit rate**
- **Measure of banks**
- **Capital produced**
- **Consumption growth (%)**

Minimum capital requirements vs. **Exit rate**

Minimum capital requirements vs. **Measure of banks**

Minimum capital requirements vs. **Capital produced**

Minimum capital requirements vs. **Consumption growth (%)**
Welfare implications

Results

Exit rate

Measure of banks

Capital produced

Consumption growth (%)

Minimum capital requirements
Welfare implications

- **Exit rate**
  - Y-axis: 3 to 5.5
  - X-axis: 0.05 to 0.25

- **Measure of banks**
  - Y-axis: 4 to 9
  - X-axis: 0.05 to 0.25

- **Capital produced**
  - Y-axis: 0.0298 to 0.03
  - X-axis: Minimum capital requirements

- **Consumption growth (%)**
  - Y-axis: 0.48 to 0.495
  - X-axis: Minimum capital requirements
Welfare implications
Welfare implications
Welfare implications

![Graphs showing welfare implications](image)

- Welfare (%)
- Bank failure (%)
- Average productivity
- Consumption–capital ratio

Minimum capital requirements
Welfare implications

- **Welfare (%)**
- **Bank failure (%)**
- **Average productivity**
- **Consumption–capital ratio**

Graphs illustrate the impact of minimum capital requirements on various economic indicators.
Welfare implications

- Welfare (%)
- Bank failure (%)
- Average productivity
- Consumption–capital ratio
Welfare implications

![Graphs showing welfare implications, bank failure, average productivity, and consumption-capital ratio vs. minimum capital requirements.](image-url)
Welfare implications

- Welfare (%)
- Bank failure (%)
- Average productivity
- Consumption–capital ratio

Minimum capital requirements

```
<table>
<thead>
<tr>
<th>Minimum capital requirements</th>
<th>Welfare (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>0.15</td>
<td>0.15</td>
</tr>
<tr>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>0.25</td>
<td>0.25</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Minimum capital requirements</th>
<th>Bank failure (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.05</td>
<td>0.98</td>
</tr>
<tr>
<td>0.1</td>
<td>1.02</td>
</tr>
<tr>
<td>0.15</td>
<td>1.04</td>
</tr>
<tr>
<td>0.2</td>
<td>1.06</td>
</tr>
<tr>
<td>0.25</td>
<td>1.08</td>
</tr>
</tbody>
</table>
```

Minimum capital requirements

```
<table>
<thead>
<tr>
<th>Minimum capital requirements</th>
<th>Average productivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.05</td>
<td>1.08</td>
</tr>
<tr>
<td>0.1</td>
<td>1.06</td>
</tr>
<tr>
<td>0.15</td>
<td>1.04</td>
</tr>
<tr>
<td>0.2</td>
<td>1.02</td>
</tr>
<tr>
<td>0.25</td>
<td>1.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Minimum capital requirements</th>
<th>Consumption–capital ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.05</td>
<td>0.076</td>
</tr>
<tr>
<td>0.1</td>
<td>0.0755</td>
</tr>
<tr>
<td>0.15</td>
<td>0.075</td>
</tr>
<tr>
<td>0.2</td>
<td>0.075</td>
</tr>
<tr>
<td>0.25</td>
<td>0.075</td>
</tr>
</tbody>
</table>
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: $\phi$

![Graph showing welfare and capital produced vs. minimum capital requirements for different values of $\phi$.](image)

- **Welfare (%)**
  - The graph plots welfare (%) against the minimum capital requirements for different values of $\phi$. The benchmark is shown by blue circles, and $\phi = 0$ is shown by red squares.

- **Capital produced**
  - The graph plots capital produced against the minimum capital requirements for different values of $\phi$. The benchmark is shown by blue circles, and $\phi = 0$ is shown by red squares.
Role of probability of bailout: $\lambda$

![Graph showing the relationship between welfare and minimum capital requirements for different values of $\lambda$. The graph includes a benchmark line and a line for $\lambda = 0.95$. The x-axis represents minimum capital requirements ranging from 0.04 to 0.24, while the y-axis represents welfare ranging from -1.5 to 2.0. The graph demonstrates how changes in $\lambda$ affect welfare and minimum capital requirements.]
Role of productivity loss due to risk-shifting: $\mu$

![Graph showing welfare, average productivity, and bank failure](image-url)
Role of additional risk exposure due to risk-shifting: $\sigma_\epsilon$

![Graph showing the relationship between welfare and minimum capital requirements for different values of $\sigma_\epsilon$. The graph compares benchmark results and results with $\sigma_\epsilon = 0.37$.](image-url)
Conclusion

- Dynamic general equilibrium banking model

- The calibrated version of the model suggests an 8% minimum Tier 1 capital requirement
  → 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