MACRO SHOCKS AND FIRM DYNAMICS WITH OLGOPOLISTIC FINANCIAL INTERMEDIARIES

JOB MARKET TALK

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Motivation

**Macro-finance with Financial Intermediaries (FIs)**

- 2008 Great Recession → more attention to FIs
- Intermediation frictions, but FIs perfectly competitive

**Observation**

- The 5 largest banks own more than 50% of the market share (e.g. JP Chase, Bank of America, Citigroup, Wells Fargo & Co., Goldman Sachs)
- Market share has doubled in the last 20 years

**Question**

- How does banking concentration affect the transmission of macro shocks?
  
  *(Aggregate shock to firms’ default probability & Lehman shock)*
Model features

• Production sector
  » Heterogeneous firms with financial frictions
    (tax shield, equity issuance cost)
  » Optimal capital structure
    (debt & equity)

• Financial sector
  » Few strategic banks
    (raise financial resources & issue defaultable loan to firms)
  » Dynamic oligopoly

• Equilibrium
  » Relation between banks’ mkt. structure & firm dynamics
Approach

- Stationary equilibrium
  (stochastic life-cycle model of firm dynamics)
    » Calibrate model using FDIC data
      (commercial & industrial loans)

- Macro shocks
  (more versus less concentrated oligopoly)
    1. Aggregate shock to firms’ default probability
    2. Lehman shock

- Extension: stationary equilibrium with firms’ endogenous default
  (credit spreads & default rates of commercial & industrial loans)

- Novel algorithm to solve for general equilibrium, heterogeneous firms, macro shocks and banks’ strategic interactions
Firms are heterogeneous

- More concentrated banking sector extracts ↑ markups out of small firms
- Small firms endogenously financially constrained

Novel mechanism: because smaller firms have higher credit demand banks exert higher market power and charge higher mark-ups on loans to small firms

Novel implications: ↓ Investment ↓ Capital ↑ σ(MPK) ↓ TFP
Mechanism in words: aggregate default shock

- Aggregate increase to firms’ default probability
- Larger proportion of small firms $\implies$ ↑ credit demand
- Markups are endogenous in the cross-section $\implies$ to remain more profitable (in the face of higher default losses) banks extract higher mark-ups out of small firms
- In equilibrium credit contracts (“credit crunch”) $\implies$
  - ↑ interest rates $\implies$ ↓ investment & capital
  - $\implies$ ↑ credit spreads
Mechanism in words: Lehman shock

One bank fails

- Surviving banks start to extend more credits to the firms in order to recover the portion of the market left uncovered by the bank that defaulted

- This happens slowly because of the effect of the strategic interactions among banks

- Implications: the aggregate availability of credits drops sharply, reducing investments and pushing output to a dynamic similar in magnitude and persistency to the one of the great recession
Bank failure

Aggregate increase to firms’ default probability
(+1.44% yearly in 2008 Great Recession)

Calibrated oligopoly

vs.

Perfect competition

Credit Spread

Output

Perfect competition
Calibrated oligopoly
Lehman shock
Data

(2008 Great Recession)

+0.40%
+0.72%
+0.96%
+0.92%

-1.40%
-2.51%
-4.00%
-4.50%


**FIRM DYNAMICS AND/OR MACRO-FINANCE (FINANCIAL FRICTIONS)**


**MACRO/IO - BANKING**


**MACRO - MONETARY POLICY TRANSMISSION**

Drechsler et al. (2017), Li et al. (2019), Scharfstein & Sunderam (2016), Wang et al. (2019)
• Simple two periods model
• Quantitative model
  » Calibration (Stationary Equilibrium)
    - Data
    - Stationary equilibrium key features
  » Macro shocks
    - Increase in aggregate firms’ default risk
    - Lehman shock
• Extension: idiosyncratic TFP shocks & endogenous default
• Conclusion
Simple Model
Given an initial distributions of firms with pdf $\phi(k_0, z_0)$

- each firm produces output $y_0 = z_0 k_0^\alpha$
- each bank finances loans issuing equity and/or debt $\int l_b(k_0, z_0) \, d\Phi(k_0, z_0)$
- each bank and firm jointly decide on a contract: loan $l_b(k_0, z_0)$, interest rate $R_l(k_0, z_0)$ and investment $k_1(k_0, z_0)$
- firms distribute dividends $d_0 = z_0 k_0^\alpha + (1 - \delta)k_0 - k_1 + \sum_b l_b$
- some firms might need to issue equity ($d_0 < 0$) at a cost $\lambda(d_0)$
Defaulting mass of firms $1 - \rho$ exit, for the surviving firms $z_1$ is realized and

- each firm produces output $y_1 = z_1 k_1^\alpha$
- each firm repays its outstanding debt plus interest $R_l(k_0, z_0) \cdot \sum_b l_b(k_0, z_0)$
- each bank distributes profit $\int \rho R_l(k_0, z_0) l_{1,b}(k_0, z_0) \, d\Phi(k_0, z_0)$
- each firm distributes dividend $d_1 = z_1 k_1^\alpha + (1 - \delta)k_1 - R_l \sum_b l_{1,b}$
Simple model: contracting

Firm and banks owners optimality conditions require

\[ R_l = \mathbb{E} \left[ 1 + \alpha z_1 k_1^{\alpha-1} - \delta \right] \quad \text{(Firm's debt)} \]  \quad (1)

\[ \rho \beta R_l = 1 - \lambda'(d_0) \quad \text{(Firm's investment)} \]  \quad (2)

\[ \rho \beta \mathbb{E} \left[ \frac{d_1}{p} \right] = 1 - \lambda'(d_0) \quad \text{(Firm's equity)} \]  \quad (3)

Given all other banks choices \( l_{-b} \), each bank \( b \) chooses a function \( l_b \) such that

\[
\max_{l_b(k_0,z_0)} \left\{ - \int l_b(k_0,z_0) \ d\Phi(k_0,z_0) + \beta \int \rho R_l(k_0,z_0) l_b(k_0,z_0) \ d\Phi(k_0,z_0) \right\}
\]

subject to \( \forall (k_0,z_0) \) (1), (2) and (3)

Each bank’s best response is characterized by the following GEE

\[
\rho \beta \left( 1 + \frac{\partial R_l}{\partial l_b} \cdot \frac{l_b(k_0,z_0)}{R_l(k_0,z_0)} \right) R_l(k_0,z_0) = 1
\]
**Firms NOT financially constrained** \((d_0 > 0)\): these firms are not affected by the banks market concentration; in equilibrium \((k_1^*, R_l^*, l_b^*, p^*)\) satisfy

1. \(k_1^* = \left( \frac{\rho^{-1} \beta^{-1} - 1 + \delta}{\alpha \mathbb{E}[z_1]} \right)^{\frac{1}{\alpha - 1}}\)

2. \(R_l^* = \rho^{-1} \beta^{-1}\)

3. \(l_b^*\) indetermined (Modigliani-Miller holds)

4. \(p^* = \rho \beta \mathbb{E} \left[ d_1^* \right] \)

**Firms financially constrained** \((d_0 \leq 0)\): for these firms the degree of imperfect competition \((B)\) matters; in equilibrium

1. \(\rho \beta \left( 1 + \frac{\partial R_l}{\partial l_b} \cdot \frac{l_b^*}{R_l^*} \right) R_l^* = 1\)

2. \(R_l^* = 1 + \alpha \mathbb{E}[z_1] k_1^{\alpha - 1} - \delta\)

3. \(\rho \beta R_l^* = 1 - \lambda'(d_0^*)\)

4. \(p^*(1 - \lambda'(d_0^*)) = \rho \beta \mathbb{E} \left[ d_1^* \right] \)
Simple model: analytical insights

Proposition

As $B$ increases:

- aggregate leverage $\int \sum_{b}^{B} \frac{l_{b}^{*}}{k_{1}^{*}} \, d\Phi$ increases;
- variance of capital $\int k_{1}^{*2} \, d\Phi - (\int k_{1}^{*} \, d\Phi)^2$ decreases;
- variance of loan interest rates $\int R_{l}^{*2} \, d\Phi - (\int R_{l}^{*} \, d\Phi)^2$ decreases;
- aggregate TFP $\int k_{1}^{*\alpha} \, d\Phi / (\int k_{1}^{*} \, d\Phi)^{\alpha}$ increases.
Simple model: mechanism dispersion

1. **Perfect competition** \( B \to \infty \), all firms "jump" to the efficient \( k^*_1 \)

2. **\( B \) finite**, firms \((d_0 < 0)\) grow slower (can't jump to \( k^*_1 \) directly)

3. **\( B \) finite**, firms \((d_0 \geq 0)\) "jump" to \( k^*_1 \)

\[ \uparrow B \implies \uparrow TFP \downarrow \sigma(MPK) \downarrow \sigma(R_1) \]
Quantitative Model
Dynamic game

In the simple 2-periods game banks choices are one shot

In the $\infty$-horizon game each bank faces a dynamic problem which:

- depends on the same bank future strategies and other banks current and future strategies
- is subject to firms dynamic demand for loans and both current and future distribution of firms matter

$\Rightarrow$ Markov-perfect equilibrium

*I borrow tools from the optimal fiscal policy literature Klein & Rios-Rull (2003), Krusell et al. (2004), Klein et al. (2008), Lanteri & Clymo (2019)*

**Other features**

i. Tax-shield  
ii. All households are risk-averse  
iii. Inter-bank market
Each firm maximizes NPV of dividends:

\[ V_F(x, X) = \max_{\{l'_b\}_b, k'} \tilde{d} + \mathbb{E} \left[ \mathcal{J}' \cdot M'_E \cdot V_F(x', X') \right] \]

- \( \tilde{d} \) is dividend at net of equity issuance cost \( d - \lambda(d) \)
- \( d = (1 - \tau) [zk'^{\alpha} - \sum_b r_l l_b] + \tau \delta k - \tilde{i} \)
- \( k' = k(1 - \delta) + i \)
- Investment \( i \) is
  - internal \( \tilde{i} \) plus
  - external \( \sum_b (l'_b - l_b) \)

State space \( \{x, X\} \):
- idiosyncratic \( x = \{\{l_b\}_b, r_l, k\} \)
- aggregates
  \( X = \{\{D\}_b, r_D, \{M_b\}_{b=0}, r_M, B, \rho, \phi(\sum_b l_b, r_l, k)\} \)

Firms optimality conditions determine the dynamic demand for loans.
Banks: overview

Bank 1

\[
V_1(X) = \max_{\{D_1', r_D', M_1', \{l_1'(.), r_1'(.), \} \}} \pi_1 + M_S' \cdot V_1(X')
\]

subject to HH and Firms FOCs

Bank 2

\[
V_2(X) = \max_{\{D_2', r_D', M_2', \{l_2'(.), r_2'(.), \} \}} \pi_2 + M_S' \cdot V_2(X')
\]

subject to HH and Firms FOCs

HH FOCs

Equity Supply

Deposits Supply

D'(X), \tilde{d}

Firms FOCs

Equity Demand

Loans Demand

l'(x, X)

D'(X), \tilde{d}

\{D_1', l_1'(.)\}

\{D_2', l_2'(.)\}

\uparrow
Markov-perfect equilibrium (fixed-point of all banks best responses)

\[
V_b(X) = \max_{\{D'_b, r'_D\}, M'_b, \{l'_b(x,X), r'_l(x,X)\}} \pi_b + M'_S(X, X') \cdot V_b(X')
\]

subject to:

\[
\pi_b = \rho \int r_l \cdot l_b \, d\Phi + r_M M_b - r_D D_b - F \quad \text{(Bank’s dividend)}
\]

\[
F + \Delta D'_b = \Delta M'_b + \rho \int \Delta l'_b(x, X) \, d\Phi \quad \text{(Law of motion)}
\]

HH & Firms’ FOCs (D supply & L demand)

\[
C_S + C_E + \int i(x, X) + \lambda(x, X) \, d\Phi + T = \int z k^\alpha \, d\Phi \quad \text{(Resource constraint)}
\]
Fix $D'_{-b}(X)$ and $l'_{-b}(x, X)$. Each bank $b$ chooses its deposit amount $D'_{b}(X)$ and its loans’ portfolio $l'_{b}(x, X)$.

An increase of one units in $l'_{b}(x, X)$:

**At time $t$:**
- needs to be covered by equity $F$ and/or $\Delta D'_{b}(X)$
- less consumption units to the saver

**At time $t+1$:**
- produces a future marginal income of $\mathbb{E} \left[ \mathcal{I}' \cdot R'_{l}(x, X) \right]$  
- decreases future loan market rate $R'_{l}(x, X)$ by $\mathbb{E} \left[ \mathcal{I}' \cdot \frac{\partial R'_{l}}{\partial l'_{b}} \right]$
Generalized Euler Equation:

\[ 1 = \mathbb{E} \left[ \mathcal{F}' \cdot M'_S(X, X') \cdot R'_l(x, X) \left( 1 + \eta'_l(x, X, x', X') \right) \right] \]

where \( \eta'_l(x, X, x', X') \equiv \frac{\partial R'_l}{\partial l'_b} \cdot \frac{l'_b(x, X)}{R'_l(x, X)} < 0. \]
Loan intermediation margin

Inter-bank rate:

\[ R'_M = \mathbb{E} \left[ \mathcal{J}' \cdot R'_l(x, X) \cdot (1 + \eta'_l(x, X, x', X')) \right] \]

\[ R'_l(x, X) - R'_M = \left( \frac{\eta'_l(x, X, x', X')}{1 + \eta'_l(x, X, x', X')} \right) \cdot \frac{1}{M'_S(X, X')} + \frac{1 - \rho}{\rho} \cdot \frac{1}{1 + \eta'_l(x, X, x', X')} \cdot \frac{1}{M'_S(X, X')} \]

1. Rents
2. Risk Premia

(1) Rents

(2) Risk Premia

\[ R'_M \quad \mathbb{E} \left[ \mathcal{J}' \cdot R'_l(x, X) \right] \quad R'_l(x, X) \]
Calibration
Commercial & Industrial Loans FDIC \((Maturity \sim 1.4 \text{ yrs})\)

Quarterly loan rate: \(r_L \approx 1.01\%\) \((Interest \ Income/Loans)\)

\(\rho = \mathbb{E} [J'] = 1 - 0.21\%\) \((Net \ Charge-Off \ Rate)\)

\(\mathbb{E} [J' \cdot R'_L - 1] = \rho \cdot R'_L - 1 \approx 0.80\%\)

Quarterly inter-bank rate: \(r_M \approx 0.54\%\) \((FED \ funds \ rate)\)
Stationary equilibrium calibration: monopoly

**Banks Moments** *(Target)*

Data: 0.264%

\[ r'_M \]

\[ \mathbb{E} \left[ \mathcal{J}' \cdot R'_L - 1 \right] \]

Model: 0.323%

\[ r'_{L,\text{data}} = 1.010\% \]

\[ r'_{L,\text{model}} = 1.071\% \]

**Firms aggregate moments**

<table>
<thead>
<tr>
<th>Moments</th>
<th>Number of Banks</th>
<th>Data (1997-2018)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>( K/Y )</td>
<td>10.46</td>
<td></td>
</tr>
<tr>
<td>( I/Y )</td>
<td>27.3%</td>
<td></td>
</tr>
<tr>
<td>( \Delta L/K )</td>
<td>0.03%</td>
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<tr>
<td>( L/K )</td>
<td>14.3%</td>
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</tbody>
</table>
Stationary equilibrium calibration: duopoly

**Banks Moments** *(Target)*

- Data: 0.264%
- Model: 0.283%

**Firms aggregate moments**

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<td></td>
<td>1</td>
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</tr>
<tr>
<td>$K/Y$</td>
<td>10.46</td>
<td>10.43</td>
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<tr>
<td>$I/Y$</td>
<td>27.3%</td>
<td>25.2%</td>
</tr>
<tr>
<td>$\Delta L/K$</td>
<td>0.03%</td>
<td>0.05%</td>
</tr>
<tr>
<td>$L/K$</td>
<td>14.3%</td>
<td>25.2%</td>
</tr>
</tbody>
</table>
Stationary equilibrium calibration: three banks

**Banks Moments** *(Target)*

\[
\mathbb{E} \left[ \mathcal{F} \cdot R_L' - 1 \right]
\]

*Data:* 0.264%

*Model:* 0.261%

**Firms aggregate moments**

<table>
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<td>25.2%</td>
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</table>
Banks’ market power reduces credit availability. Smaller firms are more reliant on banks credits, hence they are harmed more

Stationary life cycle of a firm: inverse elasticity

Mark-ups are endogenous in the cross-section
Stationary life cycle of a firm: inverse elasticity

Mark-ups are endogenous in the cross-section
A constant mark-up approach would shift $\eta_L$ uniformly
Macro Shocks
Aggregate firms’ default shock

Quarterly default rate \(1 - \rho\) (2008Q1-2012Q2)
Aggregate firms’ default shock: dynamics

$\sum_b B L_b \% \text{ change}$

- **Oligopoly**
- **Perfect competition**

↑ $1 - \rho \Rightarrow$ credit crunch
downward investment
Aggregate firms’ default shock: dynamics

\[ Y \text{ [% change]} \]

\[ r_L - r_M \text{ [% difference]} \]

↑ 1 − \( \rho \)  \( \implies \)  ↓ capital  \( \implies \)  ↑ MPK
WHAT IF THE SHOCK ORIGINATED IN THE FINANCIAL SECTOR?
Lehman shock: loan per bank

Loan per bank $L_b$ [% change]

- Oligopoly
- Perfect competition
- Lehman shock
- Data

Time $t$
Lehman shock: output

Output $Y$ [% change]

- Oligopoly
- Perfect competition
- Lehman shock
- Data

Time $t$
Lehman shock: credit spread

Credit spread $r_L - r_M$ [% difference]

- Oligopoly
- Perfect competition
- Lehman shock
- Data
Idiosyncratic TFP shocks and endogenous firms’ default

\[ \tilde{V}_F(x, X) = \max_{\{l'_b\}_b, k'} \left( d - \lambda(d) + \mathbb{E} \left[ M'_E \cdot V_F(x', X') \right] \right) \]

\[ V_F(x, X) = \max \{ \tilde{V}_F(x, X), 0 \} \]

- \( d = (1 - \tau) [zk^\alpha - \sum_b r_l l_b] + \tau \delta k - \tilde{i} - \chi \)
- State space \( \{x, X\} \):
  - idiosyncratic \( x = \{\{l_b\}_b^B, r_l, k, z\} \)
  - aggregates \( X = \{\{D\}_b^B, r_D, \{M_b\}_{b=0}^B, r_M, B, \phi(\sum_b^B l_b, r_l, k, z)\} \)

Each bank needs to dynamically best respond to other banks issuing contracts that consider firms’ exit contingent on \( z \)
### Moments

<table>
<thead>
<tr>
<th>Firms</th>
<th>Number of Banks</th>
<th>Data</th>
</tr>
</thead>
<tbody>
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<td>1</td>
<td>2</td>
</tr>
<tr>
<td>K/Y</td>
<td>10.53</td>
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<tr>
<td>I/Y</td>
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<tr>
<td>L/K</td>
<td>8%</td>
<td>16%</td>
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<tr>
<td>Default rate</td>
<td>0.004%</td>
<td>0.051%</td>
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</table>

<table>
<thead>
<tr>
<th>Banks</th>
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<th></th>
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<tbody>
<tr>
<td>r_L</td>
<td>1.34%</td>
<td>1.32%</td>
<td>1.24%</td>
<td>1.05%</td>
<td>0.91%</td>
</tr>
<tr>
<td>$\mathbb{E}[\mathcal{J} \cdot r_L] - r_M$</td>
<td>0.795%</td>
<td>0.773%</td>
<td>0.685%</td>
<td>0.259%</td>
<td>0.065%</td>
</tr>
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**Parameters**
Conclusion
**Methodology**
This paper provides a new dynamic framework that relates banks’ market structure to firm dynamics with endogenous mark-ups in time and in the cross-section
*(mechanism of endogenous financial frictions)*

**Experiment**
Lehman shock in a oligopoly framework with strategic interaction can explain the magnitude and persistency of the great recession

**Policy**
Interaction between banks’ market power and firms’ endogenous default opens policy question about optimal banks’ market structure

**Future work**
Endogenous firms’ entry decisions and relationship loans
THANK YOU
Empirical facts: Lerner index >0 & RWA ↓

Empirical facts: market concentration ↑ since 1995

Source: FDIC    Release: Summary of Deposits survey of branch
<table>
<thead>
<tr>
<th>Agents</th>
<th>Description</th>
<th>Parameter</th>
<th>Value</th>
<th>Target/Source</th>
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<tr>
<td>Household</td>
<td>Discount Factor</td>
<td>$\beta$</td>
<td>0.9942</td>
<td>Match deposit rate (Source: FDIC)</td>
</tr>
<tr>
<td></td>
<td>Risk Aversion</td>
<td>$\gamma$</td>
<td>1</td>
<td></td>
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<tr>
<td>Firms</td>
<td>Depreciation Rate</td>
<td>$\delta$</td>
<td>0.025</td>
<td>Bureau of Economic Analysis</td>
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<tr>
<td></td>
<td>Effective Capital Share</td>
<td>$\alpha$</td>
<td>0.39</td>
<td>Bureau of Labor Statistics</td>
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<tr>
<td></td>
<td>Taxation</td>
<td>$\tau$</td>
<td>0.241</td>
<td>Tax Corp Income/ Corp Profit (Source: FRED)</td>
</tr>
<tr>
<td></td>
<td>Default rate</td>
<td>$1 - \rho$</td>
<td>0.21%</td>
<td>Quarterly Net write-off to loan (Source: FDIC)</td>
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<tr>
<td></td>
<td>Equity Issuance Cost</td>
<td>$\lambda_0$</td>
<td>0.75</td>
<td>Covas &amp; den Haan (2011)</td>
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<td>Number of Banks</td>
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<td>Calibrated to match intermediation margins</td>
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<td>Agents</td>
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<td>Parameter</td>
<td>Value</td>
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<td>Persistence TFP</td>
<td>$\rho_z$</td>
<td>0.9</td>
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<tr>
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<td>Std TFP</td>
<td>$\sigma_z$</td>
<td>0.2</td>
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<td>Fixed cost</td>
<td>$\chi$</td>
<td>0.058</td>
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<td>Banks</td>
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<td>$B$</td>
<td>4</td>
<td>Calibrated to match intermediation margins</td>
</tr>
</tbody>
</table>
Additional constraints of the bank’s problem

1. Banks’ equity: \( M_S' \cdot \frac{p_b' + \pi_b'}{p_b} = 1 \)
2. Banks’ debt: \( M_S' \cdot R_D' = 1 \)
3. Firms’ debt: \( \rho \cdot M_E' \cdot (1 + (1 - \tau)r_l') \cdot \mathbb{E} \left[ (1 - \lambda'_d) \right] = 1 - \lambda_d \)
4. Firms’ equity: \( \mathbb{E} \left[ F' \cdot M_E' \cdot \frac{p' + \tilde{d}'}{p} \right] = 1 \)
5. Firms’ investment: \( \mathbb{E} \left[ 1 - \lambda'_d \right] r_l' = \mathbb{E} \left[ \left( z' \alpha k'^{\alpha-1} - \delta \right) \cdot \left( 1 - \lambda'_d \right) \right] \)
Proposition

As \( B \) increases:

- aggregate loans per bank \( \int l_b^* \, d\Phi \) decreases;
- average loan interest rate \( \int R_l^* \, d\Phi \) decreases;
- aggregate share expected returns \( \int \mathbb{E} \left[ d_{1}^* \right] / p^* \, d\Phi \) decreases;
- aggregate physical investment \( \int k_1^* - (1 - \delta)k_0 \, d\Phi \) increases;
- aggregate loans \( \int \sum_b^B l_b^* \, d\Phi \) increases;
- aggregate leverage \( \int \sum_b^B l_b^*/k_1^* \, d\Phi \) increases;

\[
\text{variance of capital } \int k_1^{*2} \, d\Phi - \left( \int k_1^* \, d\Phi \right)^2 \text{ decreases;}
\]

\[
\text{variance of loan interest rates } \int R_l^{*2} \, d\Phi - \left( \int R_l^* \, d\Phi \right)^2 \text{ decreases;}
\]

\[
\text{variance of expected returns } \int \left( \mathbb{E} \left[ d_{1}^* \right] / p^* \right)^2 \, d\Phi - \left( \int \mathbb{E} \left[ d_{1}^* \right] / p^* \, d\Phi \right)^2 \text{ decreases;}
\]

\[
\text{aggregate TFP } \int k_1^{*\alpha} \, d\Phi / \left( \int k_1^* \, d\Phi \right)^{\alpha} \text{ increases.}
\]
Simple model: mechanism

Demand for loan: FOCs of the firms

For each financially constrained firm \((d_0^* < 0)\), the spread between the equilibrium rate and the competitive rate is given by

\[
R_l^*(k_0, z_0) - \frac{1}{\rho \beta} = -\frac{\lambda'(d_0^*(k_0, z_0))}{\rho \beta}
\]

Larger firms borrow at lower rates

\[
R_l^* = 1 + \alpha \mathbb{E}[z_1] k_1^{*\alpha-1} - \delta
\]

Banks strategically interact “through” the inverse elasticity \(\eta\) of the GEE

\[
R_l^* = \left( \frac{1}{1 + \eta} \right) \cdot \frac{1}{\rho \beta}, \quad \eta = \frac{\partial R_l^*}{\partial l_b} \frac{l_b^*}{R_l^*} = \frac{\lambda'(d_0^*)}{\rho \beta}
\]

\[
\uparrow B \implies \downarrow l_b^* \quad \uparrow B \cdot l_b^* \quad \uparrow k_1^* \quad \downarrow \text{MPK} \quad \downarrow R_l^* \quad \downarrow \mathbb{E} \left[ d_1^* \right] / p^*
\]
Credit spreads

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial &amp; Industrial Loan Rates Spreads over intended federal funds rate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Market share of top 5 banks (%)</td>
<td>0.040***</td>
<td>0.053***</td>
<td>0.056***</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.006)</td>
<td>(0.007)</td>
</tr>
<tr>
<td>Net Charge-Off Rate (%)</td>
<td>0.337***</td>
<td>0.295***</td>
<td>0.272***</td>
</tr>
<tr>
<td></td>
<td>(0.051)</td>
<td>(0.051)</td>
<td>(0.059)</td>
</tr>
<tr>
<td>Comm. &amp; Ind. Loans ($tn)</td>
<td>-0.391***</td>
<td>-0.345**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.139)</td>
<td>(0.152)</td>
<td></td>
</tr>
<tr>
<td>Maturity</td>
<td></td>
<td>-0.121</td>
<td>(0.157)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.434**</td>
<td>0.384**</td>
<td>0.406**</td>
</tr>
<tr>
<td></td>
<td>(0.183)</td>
<td>(0.177)</td>
<td>(0.179)</td>
</tr>
<tr>
<td>Observations</td>
<td>81</td>
<td>81</td>
<td>81</td>
</tr>
<tr>
<td>R²</td>
<td>0.644</td>
<td>0.677</td>
<td>0.680</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.635</td>
<td>0.664</td>
<td>0.663</td>
</tr>
<tr>
<td>Residual Std. Error</td>
<td>0.291 (df = 78)</td>
<td>0.279 (df = 77)</td>
<td>0.280 (df = 76)</td>
</tr>
<tr>
<td>F Statistic</td>
<td>70.500*** (df = 2; 78)</td>
<td>53.802*** (df = 3; 77)</td>
<td>40.292*** (df = 4; 76)</td>
</tr>
</tbody>
</table>

Note: *p<0.1; **p<0.05; ***p<0.01