Sorting Out the Real Effects of Credit Supply

Briana Chang
UW-Madison

Matthieu Gomez
Columbia University

Harrison Hong
Columbia University

July 2020

Sorting Out the Real Effects of Credit Supply

Briana Chang
UW-Madison

Matthieu Gomez
Columbia University

Harrison Hong
Columbia University

July 2020

Credit supply effects on macroeconomic variables

- Bank lending channel and corporate activity
  - Bernanke and Blinder '88, Bernanke and Gertler '89, Kashyap, Stein and Wilcox '93
- Panel regression approach: compare firms of hit banks to firms of non-hit banks
  - Cross-sectional versus firm fixed effects estimators (Khwaja and Mian '08)
- Great Recession: drop in lending to corporate borrowers of hit banks
  - Hit banks co-syndicated loans with Lehman or low deposit to asset ratios (Ivashina and Scharfstein '10)
  - Investment and employment effects (Chodorow-Reich '13)

Challenges of existing approach

- Requires identifying variations in bank health uncorrelated with firm riskiness
  - Often hard to justify due to sorting
  - Great Recession: banks with securitization talent lent to riskiest firms pre-crisis
- Silent on how to relate the cross-sectional effect of bank health to aggregate effect on total lending
  - 4000 (pre- 2008 crisis) versus 2500 firms (during crisis-period): what fraction due to credit supply?

Develop Alternative Approach

- Competitive matching model of credit market to confront sorting
  - Banks with lowest holding costs lend to riskiest firms
  - Firm's ability to borrow depends on the *entire* distribution of banks' holding costs
- Estimate bank holding cost distribution
- Disentangle the effects of bank holding costs and firm riskiness on aggregate lending
  - Which type of bank gets hit matters
- Complementary to panel regression approach

Borrower Characteristics

- Keep borrowers in Dealscan that obtained loans between 2004 and 2008 or prior to 2004 but loan matured after 2007
- Exclude loans to financial firms

1. Average of all-in-drawn *loan spread*—loan credit spread over LIBOR plus annual fees to the lenders from Dealscan
2. *Bond spread*—average spread of public bonds issued by the borrower, measured in January 2007 from Fixed Income Securities Database (FISD) and Lehman Corporate Bond Data
   - Borrower level spread is average of the spread of all outstanding bonds in January 2007 weighted by face value
   - Only available for public firms and covers 30% of the initial sample of all borrowers
3. *Market leverage* of each firm in January 2007: ratio of market value of asset to market value of equity

Bank Characteristics

1. Bank *lending growth* ΔL_{it} during the financial crisis:

$$\Delta L_{it} = \frac{L_{\text{crisis}}}{L_{\text{normal}}}$$

   L_{crisis} loans originated from 10/2008 to 06/2009 and L_{normal} half of loans originated in 10/2005 to 06/2006 and 10/2006 to 06/2007

2. *Lehman distance*: fraction of a bank's syndication portfolio where Lehman Brothers has no lead role

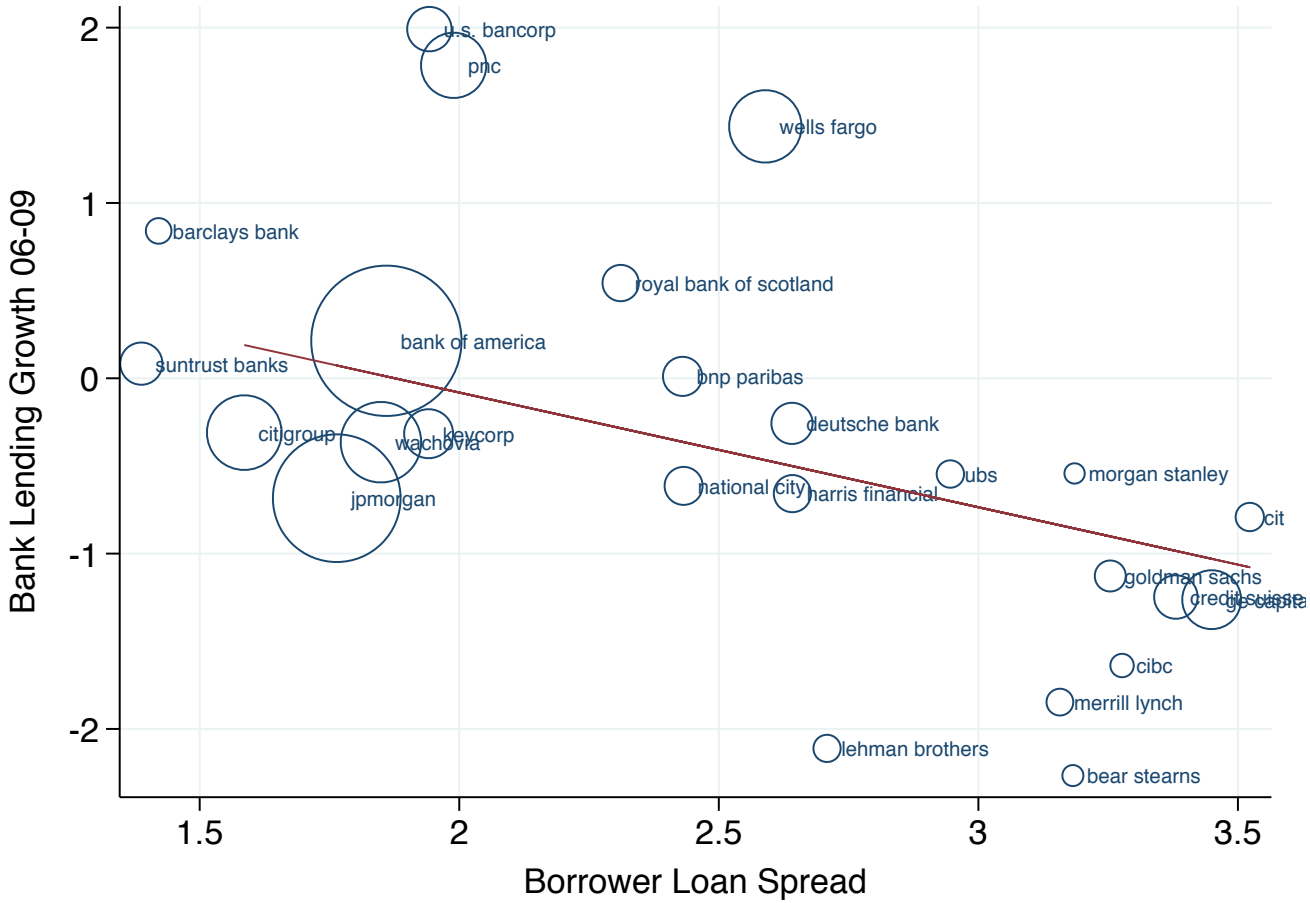
3. Ratio of *bank deposit to asset*

Sorting on Observables

	β	t-stat	R^2	N
	(1)	(2)	(3)	(4)
Panel A: Bank Lending Growth 06-09				
Borrower Loan Spread	-0.65^{***}	3.25	0.19	43
Borrower Bond Spread	-0.70^{***}	4.21	0.21	38
Borrower Leverage	-3.65^{***}	3.32	0.24	43
Panel B: Bank Lehman Distance				
Borrower Loan Spread	-1.37^{***}	3.39	0.37	42
Borrower Bond Spread	-1.18^{***}	3.34	0.24	37
Borrower Leverage	-8.33^{***}	3.99	0.52	42
Panel C: Bank Deposit				
Borrower Loan Spread	-1.24^{***}	5.30	0.48	43
Borrower Bond Spread	-1.06^{***}	4.07	0.32	38
Borrower Leverage	-6.15^{***}	6.55	0.47	43

Notes: This table estimates the model $Y_i = \alpha + \beta \overline{X}_i + \epsilon_i$, where i denotes a bank, Y_i is alternatively the bank lending growth from 2006-2009 (Panel A), Bank Lehman Distance (Panel B), Bank Deposit (Panel C). $\overline{X}_i$ denotes the average observable of borrowers from bank i in 2004-2006.WLS t-statistics in parenthesis.

Bank Lending Growth 2006-2009 and Firm Loan Spread



Downside Risk and CAPX Growth during the Financial Crisis

	Borrower CAPX Growth 06-09					
	(1)	(2)	(3)	(4)	(5)	(6)
Borrower Loan Spread	-.05***	-.05***				
	(-3)	(-2.7)				
Borrower Bond Spread			-.049***	-.048***		
			(-2.8)	(-2.6)		
Borrower Leverage					-.13**	-.18***
					(-2.3)	(-3.1)
Bank FE	No	Yes	No	Yes	No	Yes
R^2	.0087	.04	.024	.098	.01	.042
N	1913	1912	599	592	1709	1708

Notes: This table estimates the model $\Delta CAPX_i = \alpha + \beta X_i + \epsilon_i$, where i denotes a firm, X_i is alternatively its loan spread, bond spread, and market leverage. OLS t-statistics in parenthesis.

Model

- Heterogeneous firms $i \in [0, N]$, w/ one project
  - requires 1 unit investment w/ NPV (extensive margin)

$$y = (1 - \delta[i])y_H[i] + \delta[i]y_L[i] - (1 + r_f)$$

  - Assumption A1. defaults if project fails $y_H[i] \geq 1 + r_f > y_L[i]$
  - Assumption A2. NPV y constant so firms ranked by their default probability $\delta'[i] > 0$
- Heterogeneous risk-neutral banks (managers) $j \in [0, N]$
  - holding cost $C(i, j)$: $C_1(i, j) \geq 0$
  - ranked by their risk management ability $C_2(i, j) \leq 0$

Firm's and Banks' Payoff

- Joint surplus between a matching pair:

$$s(i,j) \equiv w(i,j|d) + u(i,j|d) = y - C(i,j)$$

where d is specified repayment of a debt contract within match (i,j)

  - Banks' payoff

$$w(i,j|d) = (1-\delta[i])d + \delta[i]y_L[i] - C(i,j) - (1+r_f).$$

  - The payoff of the firm

$$u(i,j|d) = (1-\delta[i])(y_H[i] - d).$$

Equilibrium

- Bank choosing firm taking equilibrium utility $U[i]$ as given:

$$W(j) = \max_i \{y - C(i,j) - U[i]\}$$

  - Fixing firm utility, lending to riskier firms leads to higher holding costs
  - All banks prefer to match with safer firms
  - $U[i]$ must decrease in i

- Matching outcome determined by which bank more willing to absorb risk

Sorting in Equilibrium

- When $C_{12}(i,j) < 0$, the equilibrium consists of a cutoff type i^* s.t.

1. For all $i \leq i^*$, matching bank is given by $j^*(i) = N - i^* + i$
   - better banks hold riskier firms
2. Firm's equilibrium payoff $U[i]$ satisfies

$$U'[i] = -C_1(i, j^*(i)) < 0,$$

with $U[i^*] = 0$

- $U'[i]$ is the marginal contribution to the surplus given $j^*(i)$
- pin down $D^*[i]$ repayment for firm i

Determinant of Loan supply

- Equilibrium condition for the marginal type i^*

$$y - C(i^*, N) = -\int_{N-i^*}^{N} C_2(i^*(j'), j')dj' > 0$$

  - the riskiest firm must be managed by the best bank N
  - benefit: positive surplus of marginal project
  - cost: worse banks for other firms
    - the cost is zero iff banks homogeneous
  - can be understood from social planner's view

Implications under Sorting

- $C(i,j) = c(\delta[i], \kappa[j])$, where $\kappa'[j] < 0$
- Talent scarcity: Fixing $\kappa[N]$, but $\kappa'[j]$ becomes steeper (less talented banks)
  - Adding a riskier firm is now more costly
  - The marginal firm can't borrow, despite his matching bank's ability remains the same
  - Interest rate increases for all active firms
  - Talented banks receive more rents

Counterfactual Exercise

- Let $t \in \{c, 0\}$: crisis vs. non-crisis period

$$i^*(\underbrace{y_t, \delta_t[i]}_{\textit{demand}}, \underbrace{\kappa_t[j]}_{\textit{supply}})$$

- The credit supply effect during the crisis:
  - Change in the supply if firms remain the same

$$\phi \equiv \frac{i^*(\delta_0[i], y_0, \kappa_0[i]) - i^*(\delta_0[i], y_0, \kappa_c[i])}{i^*(\delta_0[i], y_0, \kappa_0[i]) - i^*(\delta_c[i], y_c, \kappa_c[i])},$$

  - denominator = change in volume when both banks/firms change (observable)

Estimate of Bank Holding Cost $\kappa[j^*(i)]$

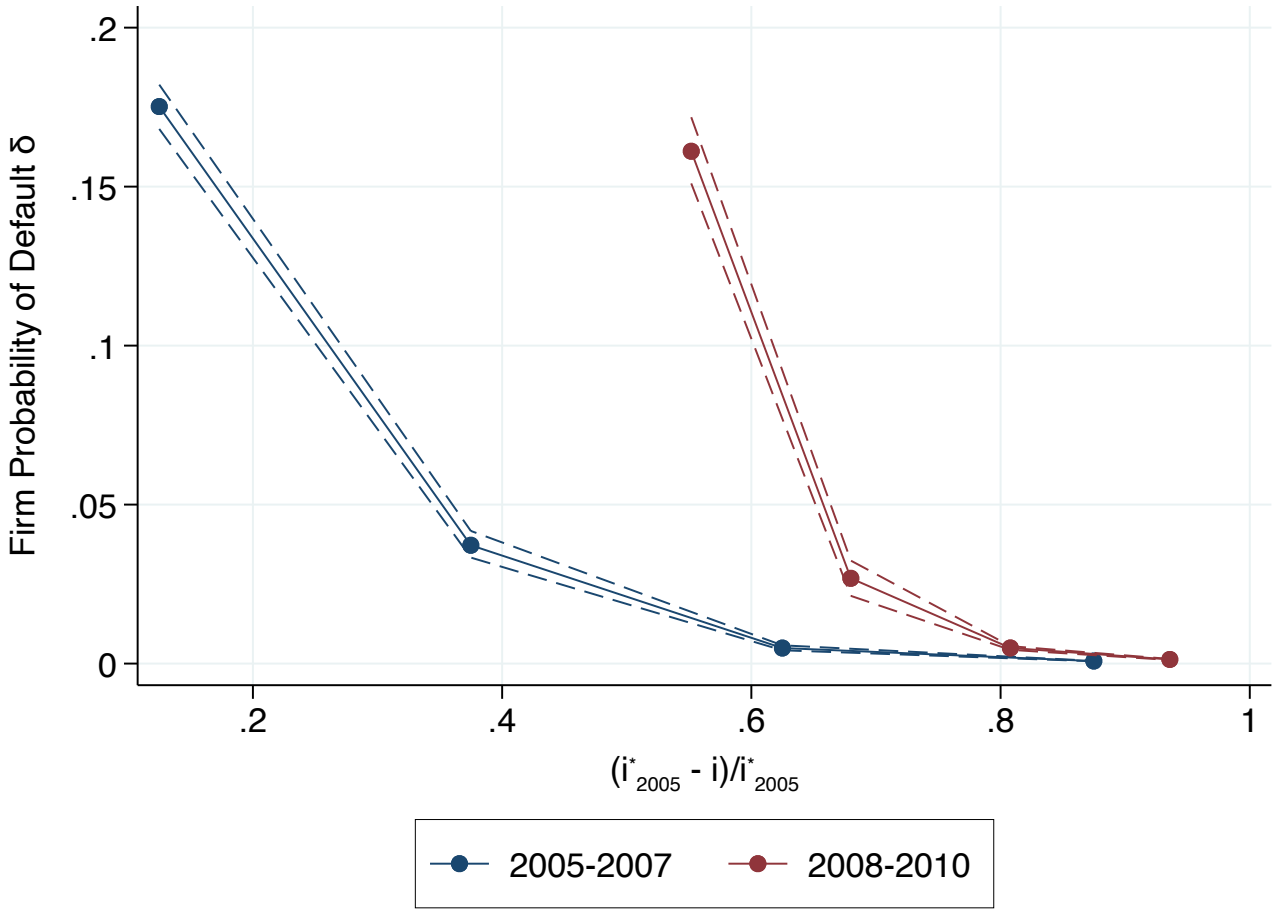
- Assumption A3. $c(\delta[i], \kappa[j]) = \delta[i]\kappa[j]$
  - Need to condition on $\delta[i]$ for more general cost function
- Holding cost estimate given by

$$\frac{L'[i]}{\delta'[i]} = \kappa[j^*(i)] = \kappa([N - (i^* - i)]), \tag{1}$$

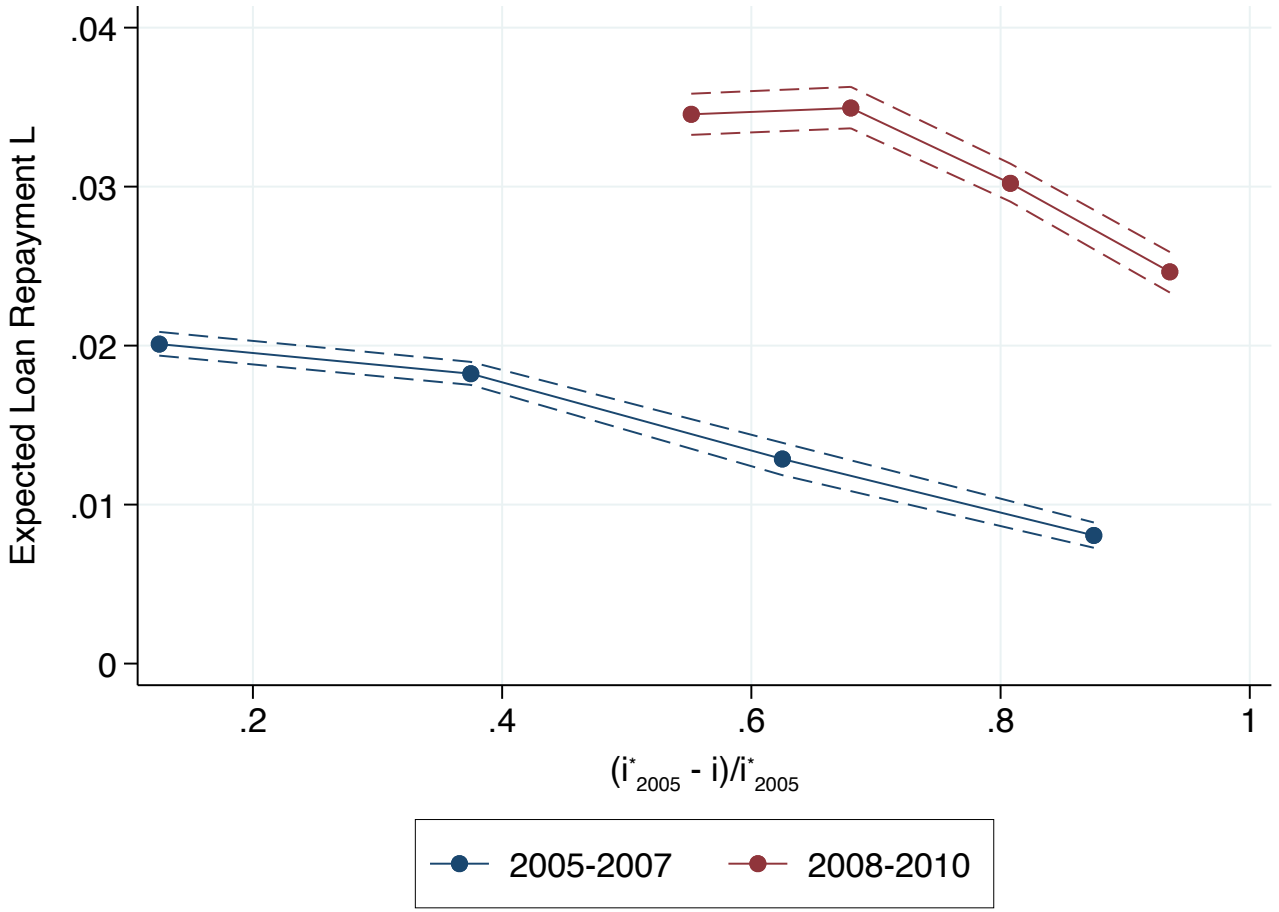
where the loan payoff to a bank when lending to firm i

$$L[i] = (1 - \delta[i])D^*[i] + \delta[i]y_L[i]$$

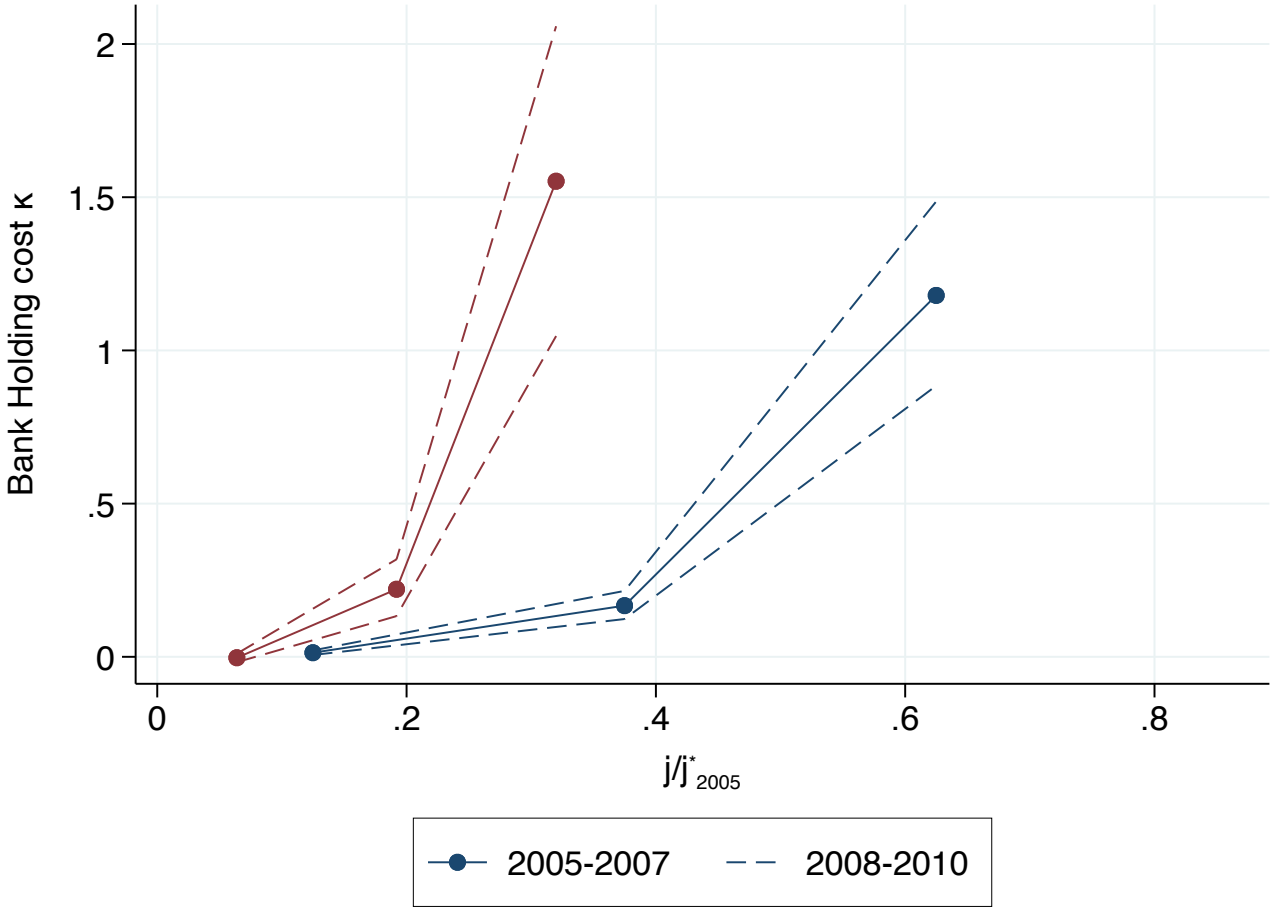
Firm Probability of Default by Credit Rating Rankings



Expected Loan Repayment by Firm Credit Rating Rankings



Bank Holding Cost by Firm Credit Rating Rankings



Calculating Counterfactual Loan Supply

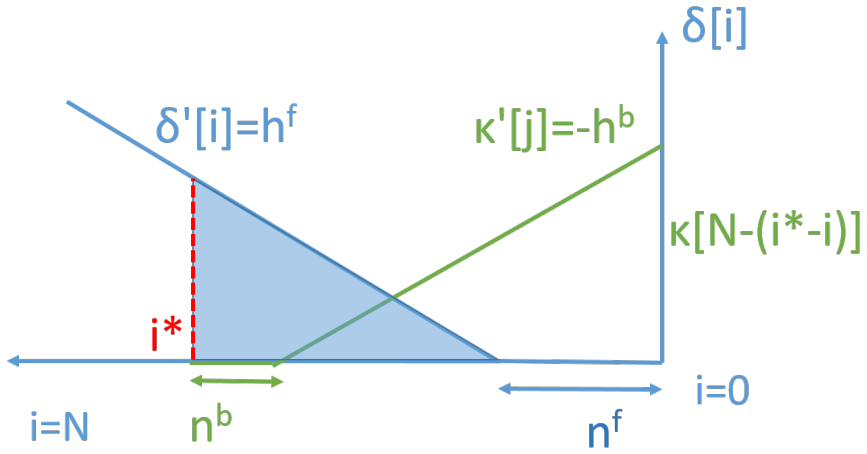


Figure: Distribution Effects on Loan supply: $y = -\int_0^{i^*} \delta[i]\kappa'[j^*(i)]di$

- Given that $h_0^b \simeq h_c^b \Rightarrow i_0^* - i^* \simeq n_0^b - n_c^b$
- If firms stay the same, change in loan supply = change measure of good banks

$$\phi = \frac{i_0^* - i^*}{i_0^* - i_c^*} = \frac{(0.38 - 0.15)^*4000}{4000 - 2500} = 0.613$$

Accounting for Endogenous Loan Size

- Optimal loan size between (i, j) maximizes

$$s(\delta[i], \kappa[j]) = \max_q y(q) - qC(\delta[i], \kappa[j]),$$

where $y'(q) > 0$ and $y''(q) < 0$.

- Adjusted κ estimate:

$$\frac{\left(\frac{L'[i]}{Q[i]}\right) - \left(\frac{y'(Q[i])}{Q[i]}\right)\frac{dQ[i]}{di}}{\delta'[i]} = \kappa[j^*(i)]$$

where

$$Q[i] = q^*(\delta[i], \kappa[j^*(i)])$$

- In the data $\frac{dQ[i]}{di}$ is approx zero

Relating to Panel Regression Approach

- Sorting test comparing with and without firm fixed effects too easily discounts selection bias
-

$$\Delta \ln Q_{ij} = \underbrace{-\chi \Delta \ln r_{ij}}_{\text{Bank Component}} \underbrace{-(\alpha - \chi)\Delta \ln \bar{r}_i + \alpha \Delta \ln A_i}_{\text{Firm Component}}$$

- Regress $\Delta \ln Q_{ij}$ on change in bank health δ_j with firm fixed effects:

$$\beta^{FE} = \chi \frac{\text{Cov}(-\Delta \ln r_{ij}, \delta_j)}{\text{Var}(\delta_j)}$$

-

$$\beta^{\text{OLS}} = \beta^{\text{FE}} + \underbrace{\alpha \frac{\text{Cov}(\Delta \ln A_i, \delta_j)}{\text{Var}(\delta_j)}}_{\text{sorting term}} + \underbrace{(\alpha - \chi) \frac{\text{Cov}(-\Delta \ln \bar{r}_i, \delta_j)}{\text{Var}(\delta_j)}}_{\text{cross elasticity term}}$$

Conclusion

- Sorting between risky firms and banks first-order concern that cannot be addressed using current methods
- Propose a new method using a competitive matching model to back out bank holding cost distribution
- Data on credit ratings and historical default rates to estimate bank holding cost distributions