Capital Requirements in a Quantitative Model of Banking Industry Dynamics

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(*Preliminary*)

[1]The views expressed here do not necessarily reflect those of the FRB Philadelphia or The Federal Reserve System.

Introduction

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Answer

- A 50% ↑ capital requirements reduces exit rates of small banks by 40% but results in a more concentrated industry. Aggregate loan supply shrinks and interest rates 50 basis points higher.

Outline

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4. Tests: (1) business cycle correlations, and (2) the bank lending channel.

Outline - continued

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3. Industry dynamics in the absence of capital requirements.
4. Countercyclical Capital Requirements (Basel III 4%→6% and 8%)

Data Summary from C-D (2011)

- Entry is procyclical and Exit by Failure is countercyclical. Fig
- Almost all Entry and Exit is by small banks. Table
- Loans and Deposits are procyclical (correl. with GDP equal to 0.72 and 0.22 respectively).
- High Concentration: Top 1% banks have 76% of loan market share in 2010. Fig Table
- Large Net Interest Margins, Markups, Lerner Index, Rosse-Panzar $H < 100$. Table
- Net marginal expenses are increasing with bank size. Fixed operating costs (normalized) are decreasing in size. Table
- Loan Returns, Margins, Markups, Delinquency Rates and Charge-offs are countercyclical. Table

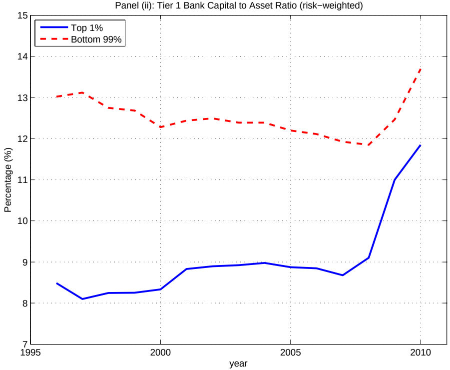
Balance Sheet Data Key Components by Size

Fraction total assets (%)	2000		2010	
	bottom 99%	top 1%	bottom 99%	top 1%
cash/fed funds sold	8.69	9.99	8.92	12.06
securities	23.39	14.25	20.94	19.11
loans	63.01	56.66	63.68	51.18
deposits	76.85	62.62	80.69	68.04
fed funds/repos/other borrow.	12.20	17.97	11.00	17.38
equity	9.44	8.07	10.61	11.13

Note: Data corresponds to commercial banks in the US. Source: Consolidated Reports of Condition and Income. Other Assets Other Liab.

- While loans and deposits are the most important parts of the bank balance sheet, "precautionary holdings" of securities are an important buffer stock.

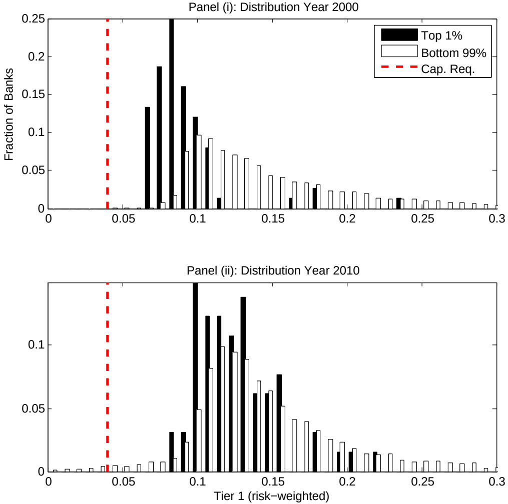
Capital Ratios by Bank Size



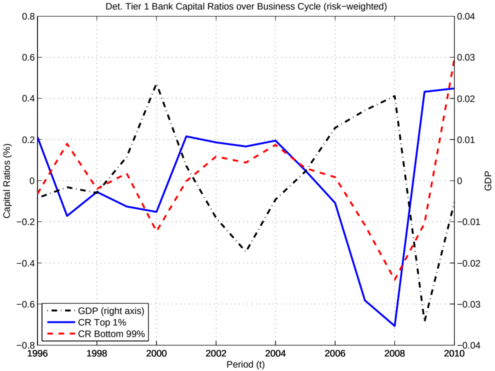
- Risk weighted capital ratios are larger for small banks.
- On average, capital ratios are above what regulation defines as "Well Capitalized" ($\geq 6\%$) suggesting a precautionary motive.

Fig. non-rw Regulation Details

Distribution of Bank Capital Ratios



Capital Ratios Over the Business Cycle



- Risk-Weighted capital ratio is countercyclical for small and big banks (corr. -0.36 and -0.76 respectively).

Fig Ratio to Total Assets (Lev. Ratio)

Model Overview

- In any aggregate state, banks intermediate between
  - unit mass of risk averse households who can deposit at a bank with deposit insurance (deposit supply).
  - unit mass of risk neutral borrowers who demand funds to undertake i.i.d. risky projects (loan demand).
  - By lending to a large number of borrowers, a given bank diversifies risk that any particular household cannot accomplish individually.

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- In the loan market, Stackelberg bank leader interacts with a competitive fringe as in Gowrisankaran and Holmes (2004).
- Deviations from Modigliani-Miller for Banks (influence costly exit):
  - Limited liability
  - Noncontingent loan contracts
  - Market power

Stochastic Processes

- Aggregate Technology Shocks $z_{t+1} \in \{z_b, z_g\}$ follow a Markov Process $F(z_{t+1}, z_t)$ with $z_b < z_g$ (business cycle).
- Conditional on z_{t+1}, project success shocks which are iid across borrowers are drawn from $p(R_t, z_{t+1})$ (non-performing loans).
- "Liquidity shocks" (capacity constraint on deposits) which are iid across banks given by $\delta_t \in \{\underline{\delta}, \ldots, \overline{\delta}\} \subseteq \mathbb{R}_{++}$ follow a Markov Process $G^\theta(\delta_{t+1}, \delta_t)$ (buffer stock).

Banks - Loan Supply

- Two types of banks $\theta \in \{b, f\}$ for big and fringe.
- They maximize the future discounted stream of dividends

$$E\left[\sum_{t=0}^{\infty} \beta^t \mathcal{D}_{t+1}^{\theta}\right]$$

- Banks face net proportional and fixed costs: (c^b, κ^b) and (c^f, κ^f).
- There is limited liability on the part of banks.
- Entry costs to create big and fringe banks are denoted $\Upsilon^b \geq \Upsilon^f \geq 0$.

Banks - cont.

- Banks make loans ℓ_t^θ and choose securities $A_t^\theta \in \mathbb{R}_+$.
- Securities have a return equal to r^a.
- Each period banks are randomly matched with a mass of depositors δ_t and decide how many deposits to accept $d_t^\theta \leq \delta_t$.
- Bank resource constraint at the beginning of the period is

$$a_t^\theta + d_t^\theta \geq \ell_t^\theta + A_t^\theta. \tag{1}$$

Banks - cont.

- After loan, deposit, and asset decisions have been made, we can define bank equity capital $\tilde{e}_t^\theta$ as

$$e_t^\theta \equiv \underbrace{A_t^\theta + \ell_t^\theta}_{\text{assets}} - \underbrace{d_t^\theta}_{\text{liabilities}} . \tag{2}$$

- Banks face a Capital Requirement:

$$e_t^\theta \geq \varphi^\theta(\ell_t^\theta + w \cdot A_t^\theta) \tag{CR}$$

where w is the "risk weighting"

Banks - cont.

- After the realization of shocks, end-of-period profits are

$$\pi_{t+1}^{\theta} = \Big\{ p(R_t, z_{t+1})(1 + r_t^L) + (1 - p(R_t, z_{t+1}))(1 - \lambda) - c^{\theta} \Big\} \ell_t^{\theta} + r^a A_t^{\theta} - (1 + r^D) d_t^{\theta} - \kappa^{\theta}.$$

Banks - cont.

- After the realization of shocks, end-of-period profits are

$$\pi^{\theta}_{t+1} = \Big\{p(R_t, z_{t+1})(1 + r^L_t) + (1 - p(R_t, z_{t+1}))(1 - \lambda) - c^{\theta}\Big\}\ell^{\theta}_t$$
$$+ r^a A^{\theta}_t - (1 + r^D)d^{\theta}_t - \kappa^{\theta}.$$

- At this stage, banks have access to end-of-period borrowing B^{θ}_{t+1} at net rate $r^B(B_{t+1})$.

- Borrowing is fully collateralized (as in repos/discount window)

$$B^{\theta}_{t+1} \leq \frac{A^{\theta}_t}{(1 + r^B)} \qquad \text{(BC)}$$

Banks - cont.

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- Beginning-of-next-period securities are defined as

$$a^\theta_{t+1} = A^\theta_t - (1 + r^B) \cdot B^\theta_{t+1} \geq 0. \quad (3)$$

Banks - cont.

- Bank dividends at the end of the period are

$$\mathcal{D}^{\theta}_{t+1} = \pi^{\theta}_{t+1} + B^{\theta}_{t+1} \geq 0. \qquad \text{(NND)}$$

- When $\pi^{\theta}_{t+1} < 0$ (negative cash flow), bank can borrow ($B^{\theta}_{t+1} > 0$) against assets (i.e. repos) to avoid exit but beginning-of-next-period's assets fall.

- When $\pi^{\theta}_{t+1} > 0$, bank can either lend/store cash ($B^{\theta}_{t+1} < 0$) raising beginning-of-next-period's assets and/or pay out dividends.

Industry State and Loan Market

- The aggregate industry state is

$$\zeta_t = \{\zeta_t^b(a,\delta), \zeta_t^f(a,\delta)\} \tag{4}$$

where each element of ζ_t is a measure $\zeta_t^\theta(a,\delta)$ corresponding to active banks of type θ over matched deposits and securities.

- Loan Market clearing:

$$\ell^b(z,\zeta) + L^{s,f}(z,\zeta,\ell^b) = L^d(r^L, z) \tag{5}$$

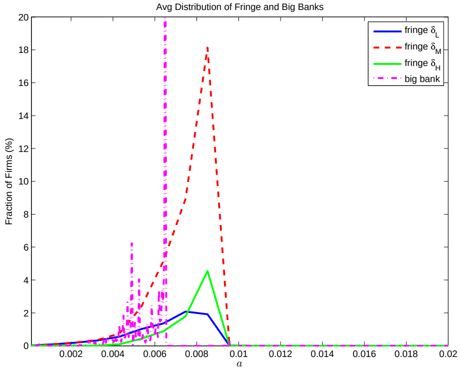
Information Timing Def. Equilibrium

Model Moments

▸ $\delta' s$/Comp. ▸ Param. i ▸ Param. ii ▸ Definitions

Moment (%)	Model	Data
Std. dev. Output	1.97	1.48
Default Frequency	2.69	2.15
Loan Int. Return	6.58	5.17
Borrower Return	12.33	12.94
Std. dev. net-int. margin	0.34	0.37
Interest Margin	5.69	5.08
Ratio profit rate top 1% to bottom 99%	99.98	63.79
Std. dev. L^s/Output	1.13	0.82
Securities to Asset Ratio Bottom 99%	6.52	20.74
Securities to Asset Ratio Top 1%	3.68	15.79
Deposit Market Share Bottom 99%	29.25	35.56
Fixed cost over loans top 1%	0.95	0.72
Fixed cost over loans bottom 99%	2.29	0.99
Entry Rate	1.55	1.60
Exit Rate	1.55	1.65
Capital Ratio (risk-weighted) Top 1%	4.23	7.50
Capital Ratio (risk-weighted) 99%	13.10	11.37
Avg. Loan Markup	111.19	102.73
Loan Market Share Bottom 99%	53.93	37.90

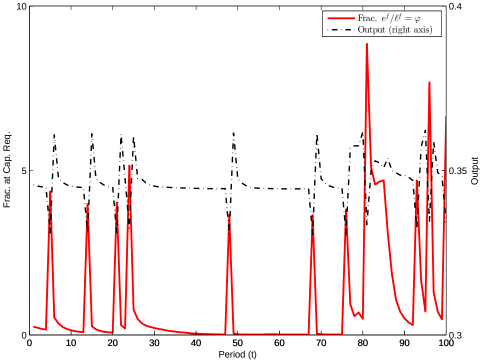
Long Run Asset Distn. of Big/Small Banks



- Average asset holdings of the big bank is lower than that of fringe banks.

Equilibrium Properties Value Entrant

Frac Banks constrained by Min Cap. Req.



- Fraction of capital requirement constrained banks rises during downturns (correlation of constrained banks and output is -0.85).

Test 1: Business Cycle Correlations

Variable Correlated with GDP	Model	Data
Exit Rate	-0.07	-0.25
Entry Rate	0.01	0.62
Loan Supply	0.97	0.58
Deposits	0.95	0.11
Loan Interest Rate r^L	-0.96	-0.18
Default Frequency	-0.21	-0.08
Loan Return	-0.47	-0.49
Charge Off Rate	-0.22	-0.18
Interest Margin	-0.47	-0.47
Markup	-0.96	-0.19
Capital Ratio Top 1% (risk-weighted)	-0.16	-0.75
Capital Ratio Bottom 99% (risk-weighted)	-0.03	-0.12

- The model does a good qualitative job with the business cycle correlations. Fig. Cap. Ratios Test 2: Bank Lending Channel

Main Counterfactual

Capital Requirement Counterfactual - Summary

Question: How much does a 50% increase of capital requirements affect outcomes?

- Higher cap. req. $\rightarrow$ banks substitute away from loans to securities $\rightarrow$ lower profitability. Figure Decision Rules
- Lower loan supply (-8%) $\rightarrow$ higher interest rates (+50 basis points), higher markups (+11%), more defaults (+12%), lower intermediated output (-9%).
- Entry/Exit drops (-45%) $\rightarrow$ lower taxes (-60%), more concentrated industry (less small banks (-14%)).

Table Comparison Role Imp. Competition Countercyclical CR

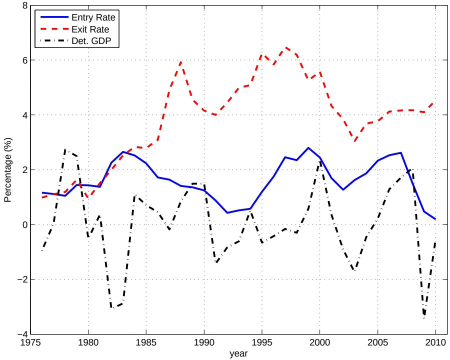
Conclusion

- First paper to pose a structural model with an endogenous bank size distribution to assess the quantitative significance of capital requirements.
- We find that Basel III proposed rise in capital requirement from 4% to 6% leads to a 40% reduction in bank exit probability, 50 basis point higher interest rates, and a more concentrated industry.
- Policy experiments show significant effects on capital ratios and balance sheet composition of banks of different sizes.
- Strategic interaction between big and small banks has important amplification effects; Volatility is higher in the imperfect competition environment.

Work to do

- Next step is to embed this IO model into a GE framework (K-T,C-P, extended with dominant firms).
- Study the predictions of a model with different capital requirements by bank size.
- Relax "deposit insurance" assumption and study the role of capital requirements in this environment

Entry and Exit Over the Business Cycle



- Trend in exit rate prior to early 90's due to deregulation
- Correlation of GDP with (Entry,Exit) =(0.25,0.22); with (Failure, Troubled, Mergers) =(-0.47, -0.72, 0.58) after 1990 (deregulation)

Exit Rate Decomposed Return

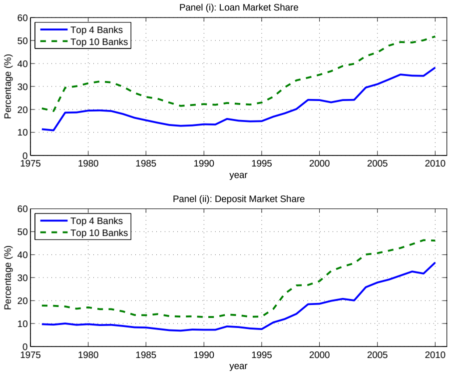
Entry and Exit by Bank Size

Fraction of Total x, accounted by:	x			
	Entry	Exit	Exit/Merger	Exit/Failure
Top 10 Banks	0.00	0.09	0.16	0.00
Top 1% Banks	0.33	1.07	1.61	1.97
Top 10% Banks	4.91	14.26	16.17	15.76
Bottom 99% Banks	99.67	98.93	98.39	98.03
Total Rate	1.71	3.92	4.57	1.35

Note: Big banks that exited by merger: 1996 Chase Manhattan acquired by Chemical Banking Corp. 1999 First American National Bank acquired by AmSouth Bancorp.

Definitions Frac. of Loans Return

Increase in Loan and Deposit Market Concentration



Return

Measures of Concentration in 2010

Measure	Deposits	Loans
Percentage of Total in top 4 Banks (C_4)	38.2	38.2
Percentage of Total in top 10 Banks	46.1	51.7
Percentage of Total in top 1% Banks	71.4	76.1
Percentage of Total in top 10% Banks	87.1	89.6
Ratio Mean to Median	11.1	10.2
Ratio Total Top 10% to Top 50%	91.8	91.0
Gini Coefficient	.91	.90
HHI : Herfindahl Index (National) (%)	5.6	4.3
HHI : Herfindahl Index (by MSA) (%)	19.6	20.7

Note: Total Number of Banks 7,092. Top 4 banks are: Bank of America, Citibank, JP Morgan Chase, Wells Fargo.

- High degree of imperfect competition $HHI \geq 15$
- National measure is a lower bound since it does not consider regional market shares (Bergstresser (2004)).

Return

Measures of Banking Competition

Moment	Value (%)	Std. Error (%)	Corr w/ GDP
Interest margin	4.56	0.30	-0.309
Markup	102.73	4.3	-0.203
Lerner Index	49.24	1.38	-0.259
Rosse-Panzar H	51.97	0.87	-

- All the measures provide evidence for imperfect competition (H<100 implies MR insensitive to changes in MC).
- Estimates are in line with those found by Berger et.al (2008) and Bikker and Haaf (2002).
- Countercyclical markups imply more competition in good times (new amplification mechanism).

Definitions Figures Return

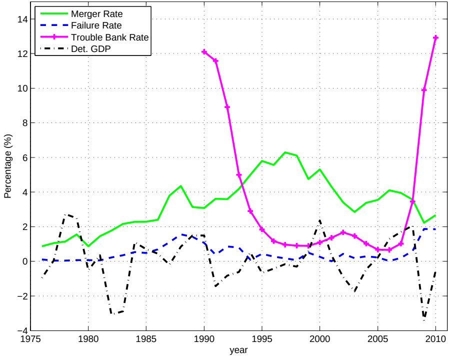
Costs by Bank Size

Moment (%)	Non-Int Inc.	Non-Int Exp.	Net Exp. (c^θ)	Fixed Cost ($\kappa^\theta/\ell^\theta$)
Top 1%	2.32†	3.94†	1.62†	0.72†
Bottom 99%	0.89	2.48	1.60	0.99

- Marginal Non-Int. Income, Non-Int. Expenses (estimated from trans-log cost function) and Net Expenses are increasing in size.
- Fixed Costs (normalized by loans) are decreasing in size.
- Selection of only low cost banks in the competitive fringe may drive the Net Expense pattern.

Definitions Return

Exit Rate Decomposed



- Correlation of GDP with (Failure, Troubled, Mergers) =(-0.47, -0.72, 0.58) after 1990

Return

Definitions Entry and Exit by Bank Size

- Let $y \in \{\text{Top 4}, \text{Top 1\%}, \text{Top 10\%}, \text{Bottom 99\%}\}$
- let $x \in \{\text{Enter}, \text{Exit}, \text{Exit by Merger}, \text{Exit by Failure}\}$
- Each value in the table is constructed as the time average of "y banks that x in period t" over "total number of banks that x in period t".
- For example, Top $y = 1\%$ banks that "$x =$enter" in period t over total number of banks that "$x =$enter" in period t.

Return

Entry and Exit by Bank Size

Fraction of Loans of Banks in x, accounted by:	x			
	Entry	Exit	Exit/Merger	Exit/Failure
Top 10 Banks	0.00	9.23	9.47	0.00
Top 1% Banks	21.09	35.98	28.97	15.83
Top 10% Banks	66.38	73.72	47.04	59.54
Bottom 99% Banks	75.88	60.99	25.57	81.14

Note: Big banks that exited by merger: 1996 Chase Manhattan acquired by Chemical Banking Corp. 1999 First American National Bank acquired by AmSouth Bancorp.

Return

Definition of Competition Measures

- The Interest Margin is defined as:

$$pr_{it}^{L} - r_{it}^{D}$$

where r^L realized real interest income on loans and r^D the real cost of loanable funds

- The markup for bank is defined as:

$$\text{Markup}_{tj} = \frac{p_{\ell_{tj}}}{mc_{\ell_{tj}}} - 1 \quad (6)$$

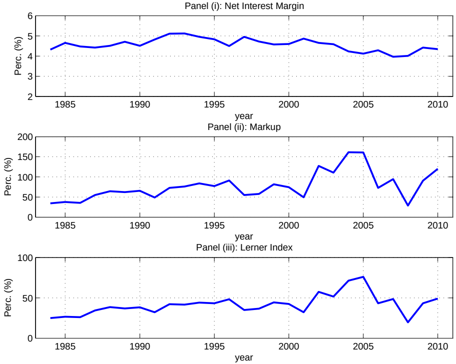
where $p_{\ell_{tj}}$ is the price of loans or marginal revenue for bank j in period t and $mc_{\ell_{tj}}$ is the marginal cost of loans for bank j in period t

- The Lerner index is defined as follows:

$$\text{Lerner}_{it} = 1 - \frac{mc_{\ell_{it}}}{p_{\ell_{it}}}$$

Return

Cyclical Properties



Return

Definitions Net Costs by Bank Size

Non Interest Income:

i. Income from fiduciary activities.
ii. Service charges on deposit accounts.
iii. Trading and venture capital revenue.
iv. Fees and commissions from securities brokerage, investment banking and insurance activities.
v. Net servicing fees and securitization income.
vi. Net gains (losses) on sales of loans and leases, other real estate and other assets (excluding securities).
vii. Other noninterest income.

Non Interest Expense:

i. Salaries and employee benefits.
ii. Goodwill impairment losses, amortization expense and impairment losses for other intangible assets.
iii. Other noninterest expense.

Fixed Costs:

i. Expenses of premises and fixed assets (net of rental income). (excluding salaries and employee benefits and mortgage interest).

Balance Sheet Other Components: Assets

- Other assets include
  - trading assets (e.g. mortgage backed securities, foreign exchange, other off-balance sheet assets held for trading purposes),
  - premises/fixed assets/other real estate (including capitalized leases),
  - investments in unconsolidated subsidiaries and associated companies,
  - direct and indirect investments in real estate ventures,
  - intangible assets
- None of them (on average, across banks/time) represent a large number as fraction of assets.
- The most significant are trading assets (4.30%), fixed assets (1.3%) and intangible assets (1.53%).
- Trading assets is available since 2005 and not consistently reported since it is required only for banks that report trading assets of 2 million or more in each of the previous 4 quarters.

Return

Balance Sheet Other Components: Liabilities

- Other liabilities include
  - Trading liabilities (includes MBS)
  - Subordinated notes and debentures
- Trading liabilities represent 3.13% and subordinated debt 1% as fraction of assets.
- Trading liabilities is available since 2005 and not consistently reported since it is required only for banks that report trading assets of 2 million or more in each of the previous 4 quarters.

Return

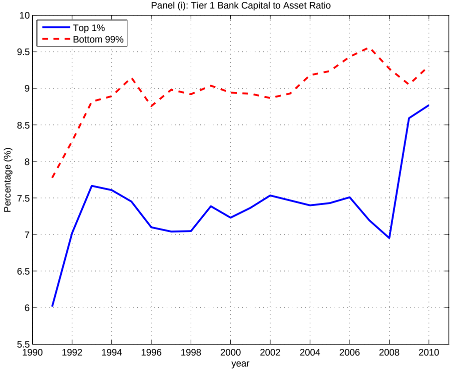
Regulation Capital Ratios

	Tier 1 to Total Assets	Tier 1 to Risk w/ Assets	Total Capital to Risk w/ Assets
Well Capitalized	$\geq 5\%$	$\geq 6\%$	$\geq 10\%$
Adequately Capitalized	$\geq 4\%$	$\geq 4\%$	$\geq 8\%$
Undercapitalized	$< 4\%$	$< 4\%$	$< 8\%$
Signif. Undercapitalized	$< 3\%$	$< 3\%$	$< 6\%$
Critically Undercapitalized	$< 2\%$	$< 2\%$	$< 2\%$

Source: DSC Risk Management of Examination Policies (FDIC). Capital (12-04).

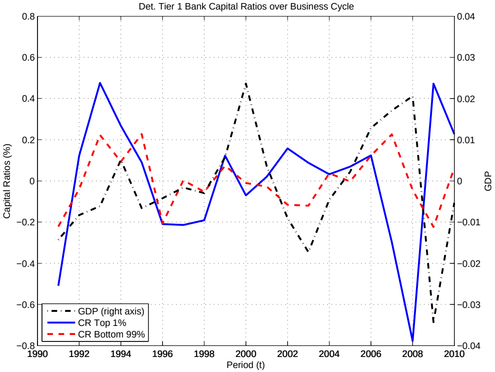
Return

Capital Ratios by Bank Size



- Capital Ratios (equity capital to assets) are larger for small banks.
- On average, capital ratios are above what regulation defines as "Well Capitalized" ($\geq 6\%$) further suggesting a precautionary motive. Return

Capital Ratio Over the Business Cycle



- Capital Ratio (over total assets) is procyclical for small banks (corr. 0.48) and countercyclical for big banks (corr. -0.45).

Return

Business Cycle Correlations

Variable Correlated with GDP	Data
Loan Interest Rate r^L	-0.18
Exit Rate	-0.47
Entry Rate	0.25
Loan Supply	0.72
Deposits	0.22
Default Frequency	-0.61
Loan Return	-0.26
Charge Off Rate	-0.56
Interest Margin	-0.31
Lerner Index	-0.26
Markup	-0.20

Return

Depositors

- Each hh is endowed with 1 unit of a good and is risk averse with preferences $u(c_t)$.
- HH's can invest their good in a riskless storage technology yielding exogenous net return $\bar{r}$.
- If they deposit with a bank they receive r_t^D even if the bank fails due to deposit insurance (funded by lump sum taxes on the population of households).
- If they match with an individual borrower, they are subject to the random process in (**??**).

Return

Borrower Decision Making

- If a borrower chooses to demand a loan, then given limited liability his problem is to solve:

$$v(r^L, z) = \max_R E_{z'|z} p(R, z') \left(z'R - r^L \right). \tag{7}$$

- The borrower chooses to demand a loan if

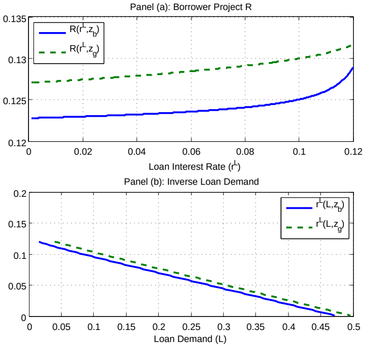
$$v(\overset{-}{r^L}, \overset{+}{z}) \geq \omega. \tag{8}$$

- Aggregate demand for loans is given by

$$L^d(r^L, z) = N \cdot \int_{\underline{\omega}}^{\overline{\omega}} 1_{\{\omega \leq v(r^L, z)\}} d\Upsilon(\omega). \tag{9}$$

Return Return Timing

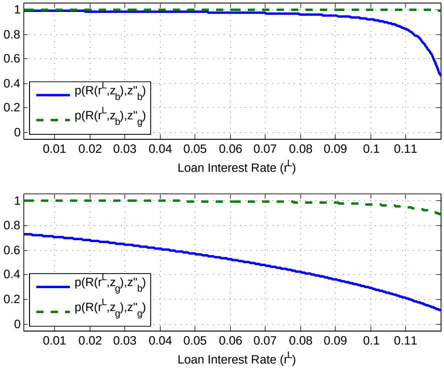
Borrower Project Choice & Inverse Loan Demand



- "Risk shifting" effect that higher interest rates lead borrowers to choose more risky projects as in Boyd and De Nicolo. Borrower Problem
- Thus higher loan rates can induce higher default frequencies. Fig.
- Loan demand is pro-cyclical.

Return Mkt Essentials Return Timing

Loan rates and default risk



- Higher loan rates induce higher default risk

Return

Information

- Only borrowers know the riskiness of the project they choose R, their outside option ω, and their consumption.
- All other information is observable (e.g. success/failure).

Return

Timing

At the beginning of period t,

1. Liquidity shocks are realized δ_t.
2. Starting from beginning of period state (ζ_t, z_t), borrowers draw ω_t.
3. Dominant bank chooses (ℓ_t^b, d_t^b, A_t^b). Big Bank Problem
4. Having observed ℓ_t^b, fringe banks choose (ℓ_t^f, d_t^f, A_t^f). Borrowers choose whether or not to undertake a project and if so, R_t. Borrower's Problem
5. Return shocks z_{t+1} are realized, as well as idiosyncratic project success shocks.
6. Banks choose B_{t+1}^{θ} and dividend policy. Exit and entry decisions are made (in that order). Entry Distribution
7. Households pay taxes τ_{t+1} to fund deposit insurance and consume. Taxes

Return

Defn. Markov Perfect Industry EQ

Given policy parameters $(\varphi^\theta, w, r^B, r^a)$, a pure strategy Markov Perfect Equilibrium (MPIE) is a set of functions $\{v(r^L, z), R(r^L, z)\}$ (borrower behavior), $\{V^\theta, \ell^\theta, d^\theta, A^\theta, B^{\theta'}, x^\theta\}$ (bank behaviour), a loan interest rate $r^L(\zeta, z)$, a deposit interest rate $r^D = \bar{r}$, the law of motion of the cross-sectional distribution $\zeta' = H(z', \zeta)$, an entry function $E(z, \zeta, z')$, and a tax function $\tau(z, \zeta, z')$ such that:

1. Given r^L, $v(r^L, z)$ and $R(r^L, z)$ are consistent with borrower's optimization.
2. At any interest rate r^L, loan demand $L^d(r^L, z)$ is given by (8).
3. At $r^D = \bar{r}$, the household deposit participation constraint is satisfied.
4. Bank functions, $\{V^\theta, \ell^\theta, d^\theta, A^\theta, B^{\theta'}, x^\theta\}$, are consistent with bank optimization.
5. The law of motion for the industry state $H(z', \zeta)$ is consistent with bank entry and exit decision rules.
6. The interest rate $r^L(\zeta, z)$ is such that the loan market clears.
7. Across all states (ζ, z, z'), taxes cover deposit insurance.

Return

Big Bank Problem

The value function of a "big" incumbent bank at the beginning of the period is then given by ▸ Current Profit Trade-offs

$$V^b(a,\delta,z,\zeta) = \max_{\ell,d\in[0,\delta],A\geq 0} \left\{\beta E_{z'|z} W^b(\ell,d,A,\zeta,\delta,z')\right\}, \tag{10}$$

s.t.

$$a+d \geq A+\ell \tag{11}$$

$$e=\ell+A-d \geq \varphi^b \ell \tag{12}$$

$$\ell + L^{s,f}(z,\zeta,\ell) = L^d(r^L,z) \tag{13}$$

where $L^{s,f}(z,\zeta,\ell)=\int \ell_i^f(a,\delta,z,\zeta,\ell^b)\zeta^f(da,d\delta)$.

- Market clearing (12) defines a "reaction function" where the dominant bank takes into account how fringe banks' loan supply reacts to its own loan supply.

▸ Fringe Decision Making ▸ Return Timing

Big Bank Problem - Cont.

The end of period function is given by

$$W^b(\ell,d,A,\zeta,\delta,z') = \max_{x\in\{0,1\}} \left\{W^{b,x=0}(\ell,d,A,\zeta,\delta,z'), W^{b,x=1}(\ell,d,A,\zeta,\delta,z')\right\}$$

$$W^{b,x=0}(\ell,d,A,\zeta,\delta,z') = \max_{B'\leq\frac{A}{(1+r^B)}} \left\{\mathcal{D}^b + E^b_{\delta'|\delta}V^b(a',\delta',z',\zeta')\right\}$$

$$\text{s.t.} \quad \mathcal{D}^b = \pi^b(\ell,d,a',\zeta,z') + B' \geq 0$$
$$a' = A - (1+r^B)B' \geq 0$$
$$\zeta' = H(z,\zeta,z')$$

$$W^{b,x=1}(\ell,d,A,\zeta,\delta,z') = \max\left\{\xi\left[\{p(R,z')(1+r^L) + (1-p(R,z'))(1-\lambda) - c^b\}\ell\right] + (1+r^a)A - d(1+r^D) - \kappa^b, 0\right\}.$$

Return Timing

Bank Entry

- Each period, there is a large number of potential type θ entrants.
- The value of entry (net of costs) is given by

$$V^{\theta,e}(z,\zeta,z') \equiv \max_{a'} \left\{-a' + E_{\delta'} V^{\theta}(a',\delta',z',H(z,\zeta,z'))\right\} - \Upsilon^{\theta} \quad (14)$$

- Entry occurs as long as $V^{\theta,e}(z,\zeta,z') \geq 0$.
- The argmax of (13) defines the initial equity distribution of banks which enter.
- Free entry implies that

$$V^{\theta,e}(z,\zeta,z') \times E^{\theta} = 0 \quad (15)$$

where E^f denotes the mass of fringe entrants and E^b the number of big bank entrants.

Return Timing

Evolution of Cross-sectional Bank Size Distribution

- The distribution of fringe banks evolves according to

$$\zeta^{f'}(a',\delta') = \int \sum_{\delta} (1 - x^f(\cdot)) I_{\{a'=\tilde{a}^f(\cdot))\}} G^f(\delta',\delta) d\zeta^f(a,\delta) + E^f \sum_{\delta} I_{\{a'=a^{f,e}(\cdot))\}} G^{f,e}(\delta). \quad (16)$$

- (15) makes clear how the law of motion for the distribution of banks is affected by entry and exit decisions.

Return Timing

Taxes to cover deposit insurance

- Across all states (ζ, z, z'), taxes must cover deposit insurance in the event of bank failure.

- Let post liquidation net transfers be given by

$$\Delta^{\theta} = (1 + r^D)d^{\theta} - \xi\Big[\{p(1 + r^L) + (1 - p)(1 - \lambda) - c^{\theta}\}\ell^{\theta} + \tilde{a}^{\theta\prime}(1 + r^a)\Big]$$

  where $\xi \leq 1$ is the post liquidation value of the bank's assets and cash flow.

- Then aggregate taxes are

$$\tau(z, \zeta, z') \cdot \Xi = \int x^f \max\{0, \Delta^f\} d\zeta^f(a, \delta) + x^b \max\{0, \Delta^b\}$$

Return Timing

Incumbent Bank Decision Making

- Differentiating end-of period profits with respect to ℓ^θ we obtain

$$\frac{d\pi^\theta}{d\ell^\theta} = \underbrace{\left[pr^L - (1-p)\lambda - r^a - c^\theta\right]}_{(+)\text{ or }(-)} + \ell^\theta \left[\underbrace{p}_{(+)} + \underbrace{\frac{\partial p}{\partial R}\frac{\partial R}{\partial r^L}(r^L + \lambda)}_{(-)}\right] \underbrace{\frac{dr^L}{d\ell^\theta}}_{(-)}$$

- $\frac{dr^L}{d\ell^f} = 0$ for competitive fringe.
- The total supply of loans by fringe banks is

$$L^{s,f}(z,\zeta,\ell^b) = \int \ell^f(a,\delta,z,\zeta,\ell^b)\zeta^f(da,d\delta). \tag{17}$$

Return

Fringe Bank Problem

The value function of a fringe incumbent bank at the beginning of the period is then given by

$$V^f(a, \delta, z, \zeta) = \max_{\ell \geq 0, d \in [0,\delta], A \geq 0} \left\{ \beta E_{z'|z} W^f(\ell, d, A, \delta, \zeta, z') \right\},$$

s.t.

$$a + d \geq A + \ell \tag{18}$$

$$\ell(1 - \varphi^f) + A(1 - w\varphi^f) - d \geq 0 \tag{19}$$

$$\ell^b(\zeta) + L^f(\zeta, \ell^b(\zeta)) = L^d(r^L, z) \tag{20}$$

Fringe banks use the decision rule of the dominant bank in the market clearing condition (19).

Return

Parameterization

Return

For the stochastic deposit matching process, we use data from our panel of U.S. commercial banks:

- Assume dominant bank support is large enough so that the constraint never binds.
- For fringe banks, use Arellano and Bond to estimate the AR(1)

$$\log(\delta_{it}) = (1-\rho_d)k_0 + \rho_d \log(\delta_{it-1}) + k_1 t + k_2 t^2 + k_{3,t} + a_i + u_{it} \quad (21)$$

  where t denotes a time trend, $k_{3,t}$ are year fixed effects, and u_{it} is iid and distributed $N(0, \sigma_u^2)$.

- Discretize using Tauchen (1986) method with 5 states. Discrete Process
- Computation: Variant of Ifrach/Weintraub (2012), Krusell/Smith (1998) Details

Parameterization

Return

Parameter		Value	Target
Dep. preferences	σ	2	Part. constraint
Agg. shock in good state	z_g	1	Normalization
Transition probability	$F(z_g, z_g)$	0.86	NBER data
Transition probability	$F(z_b, z_b)$	0.43	NBER data
Deposit interest rate (%)	$\bar{r} = r^d$	0.86	Int. expense
Net. non-int. exp. n bank	c^b	1.62	Net non-int exp. Top 1%
Net. non-int. exp. r bank	c^f	1.60	Net non-int exp. bottom 99%
Charge-off rate	λ	0.21	Charge off rate
Autocorrel. Deposits	ρ_d	0.84	Deposit Process Bottom 99%
Std. Dev. Error	σ_u	0.19	Deposit Process Bottom 99%
Securities Return (%)	r^a	1.20	Avg. Return Securities
Cost overnight funds	r^B	1.20	Avg. Return Securities
Capital Req. top 1%	(φ^b, w)	$(4.0, 0)$	Capital Regulation
Capital Req. bottom 99%	(φ^f, w)	$(4.0, 0)$	Capital Regulation

Parameters Chosen within Model

Return

Parameter		Value	Targets
Agg. shock in bad state	z_b	0.969	Std. dev. Output
Weight agg. shock	α	0.883	Default freq.
Success prob. param.	b	3.773	Loan interest return
Volatility borrower's dist.	σ_ϵ	0.059	Borrower Return
Success prob. param.	ψ	0.784	Std. dev. net-int. margin
Mean Entrep. project Dist.	μ_e	-0.85	Ratio Profits Top 1% to bottom 99%
Max. reservation value	$\overline{\omega}$	0.227	Net Interest Margin
Discount Factor	β	0.95	Sec. to asset ratio Bottom 99%
Salvage value	ξ	0.70	Sec. to asset ratio Top 1%
Mean Deposits	μ_d	0.04	Deposit mkt share bottom 99%
Fixed cost b bank	κ^b	0.100	Fixed cost over loans top 1%
Fixed cost f banks	κ^f	0.001	Fixed cost over loans bottom 99%
Entry Cost b bank	Υ^b	0.050	Std. dev. L^s/Output
Entry Cost f banks	Υ^f	0.006	Bank entry rate

Note: Functional Forms

Computing the Model

- Solve the model using a variant of Krusell and Smith (1998) and Farias et. al. (2011).

- We approximate the distribution of fringe banks using average assets $\bar{A}$, average deposits $\bar{\delta}$ and the mass of incumbent fringe banks $\mathcal{M}$ where

$$\mathcal{M} = \int \sum_{\delta} d\zeta^f(a, \delta)$$

- Note that the mass of entrants E^f and $\mathcal{M}$ are linked since

$$\zeta^{f'}(a', \delta') = T^*(\zeta^f(a, \delta)) + E^f \sum_{\delta} I_{a'=a^{f,e}} G^{f,e}(\delta)$$

where $T^*(\cdot)$ is the transition operator.

Return Parametrization

Computational Algorithm (cont.)

1. Guess **aggregate functions**. Make an initial guess of $\ell^f(\bar{A}, z, a^b, \mathcal{M}, \ell; \bar{\delta})$ that determines the reaction function and the law of motion for $\bar{A}'$ and $\mathcal{M}'$.

2. Solve the **dominant bank** problem.

3. Solve the problem of **fringe banks**.

4. Using the solution to the fringe bank problem V^f, solve the **auxiliary problem** to obtain $\ell^f(\bar{A}, z, a^b, \mathcal{M}, \ell; \bar{\delta})$.

5. Solve the **entry problem** of the fringe bank and big bank to obtain the number of entrants as a function of the state space.

6. **Simulate** to obtain a sequence $\{a_t^b, \bar{A}_t, \mathcal{M}_t\}_{t=1}^T$ and update aggregate functions.

Return Parametrization

Computational Algorithm (cont.)

- We approximate the fringe part by $\bar{A}'$ and $\mathcal{M}'$ that evolve according to

$$\log(\overline{A}') = h_0^a + h_1^a \log(z) + h_2^a \log(a^b) + h_3^a \log(\overline{A}) + h_4^a \log(M) + h_5^a \log(z$$
$$\log(\mathcal{M}') = h_0^m + h_1^m \log(z) + h_2^m \log(a^b) + h_3^m \log(\overline{A}) + h_4^m \log(\mathcal{M}) + h_5^m \log(z$$

- We approximate the equation defining the "reaction function" $L^f(z,\zeta,\ell)$ by $L^f(z,a^b,\overline{A},\mathcal{M},\ell)$ with

$$L^f(z,a^b,\bar{A},\mathcal{M},\ell) = \ell^f(\bar{A},z,a^b,\mathcal{M},\ell) \times M \qquad (22)$$

where $\ell^f(\bar{A},z,a^b,\mathcal{M},\ell)$ is the solution to an auxiliary problem

Return Parametrization

Markov Process Matched Deposits

- The finite state Markov representation $G^f(\delta', \delta)$ obtained using the method proposed by Tauchen (1986) and the estimated values of μ_d, ρ_d and σ_u is:

$$G^f(\delta', \delta) = \begin{bmatrix} 0.632 & 0.353 & 0.014 & 0.000 & 0.000 \\ 0.111 & 0.625 & 0.257 & 0.006 & 0.000 \\ 0.002 & 0.175 & 0.645 & 0.175 & 0.003 \\ 0.000 & 0.007 & 0.257 & 0.625 & 0.111 \\ 0.000 & 0.000 & 0.014 & 0.353 & 0.637 \end{bmatrix},$$

- The corresponding grid is $\delta \in \{0.019, 0.028, 0.040, 0.057, 0.0.081\}$.

- The distribution $G^{e,f}(\delta)$ is derived as the stationary distribution associated with $G^f(\delta', \delta)$.

Return

Functional Forms

- Borrower outside option is distributed uniform $[0, \overline{\omega}]$.
- For each borrower, let $y = \alpha z' + (1-\alpha)\varepsilon - bR^{\psi}$ where ε is drawn from $N(\mu_{\varepsilon}, \sigma_{\varepsilon}^2)$.
- Define success to be the event that $y > 0$, so in states with higher z or higher ε_e success is more likely. Then

$$p(R, z')1 - \Phi\left(\frac{-\alpha z' + bR^{\psi}}{(1-\alpha)}\right) \quad (23)$$

where $\Phi(x)$ is a normal cumulative distribution function with mean (μ_{ε}) and variance σ_{ε}^2.

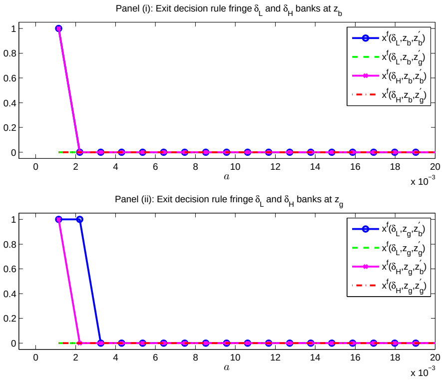
Return

Definition Model Moments

Aggregate loan supply	$L^s(z,\zeta) = \ell^b + L^f(z,\zeta,\ell^b)$
Aggregate Output	$L^s(z,\zeta)\Big\{p(z,\zeta,z')(1+z'R) + (1-p(z,\zeta,z'))(1-\lambda)\Big\}$
Entry Rate	$E^f / \int \zeta(a,\delta)$
Default frequency	$1 - p(R^*, z')$
Borrower return	$p(R^*, z')(z'R^*)$
Loan return	$p(R^*, z')r^L(z,\zeta) + (1-p(R^*, z'))\lambda$
Loan Charge-off rate	$(1-p(R^*, z'))\lambda$
Interest Margin	$p(R^*, z')r^L(z,\zeta) - r^d$
Loan Market Share Bottom 99%	$L^f(\zeta,\ell^b(\zeta))/\Big(\ell^b(\zeta) + L^f(\zeta,\ell^b(\zeta))\Big)$
Deposit Market Share Bottom 99%	$\frac{\int_{a,\delta} d^f(a,\delta,z,\zeta)d\zeta(a,\delta)}{\int_{a,\delta} d^f(a,\delta,z,\zeta)d\zeta(a,\delta)+d^b(a,\delta,z,\zeta)}$
Capital Ratio Bottom 99%	$\int_{a,\delta}[\tilde{e}^f(a,\delta,z,\zeta)/\ell^f(a,\delta,z,\zeta)]d\zeta(a,\delta)/\int_{a,\delta} d\zeta(a,\delta)$
Capital Ratio Top 1%	$\tilde{e}^b(a,\delta,z,\zeta)/\ell^b(a,\delta,z,\zeta)$
Securities to Asset Ratio Bottom 99%	$\frac{\int_{a,\delta}[\tilde{a}^f(a,\delta,z,\zeta)/(\ell^f(a,\delta,z,\zeta)+\tilde{a}^f(a,\delta,z,\zeta))]d\zeta(a,\delta)}{\int_{a,\delta} d\zeta(\tilde{a},\delta)}$
Securities to Asset Ratio Top 1%	$\tilde{a}^b(a,\delta,z,\zeta)/(\ell^b(a,\delta,z,\zeta) + \tilde{a}^b(a,\delta,z,\zeta))$
Profit Rate	$\frac{\pi_{\ell_i(\theta)}(\cdot)}{\ell_i(\theta)}$
Lerner Index	$1 - \Big[r^d + c^{\theta,exp}\Big] / \Big[p(R^*(\zeta,z),z',s')r^L(\zeta,z) + c^{\theta,inc}\Big]$
Markup	$\Big[p^j(R^*(\zeta,z),z',s')r^L(\zeta,z) + c^{\theta,inc}\Big] / \Big[r^d + c^{\theta,exp}\Big] - 1$

Return

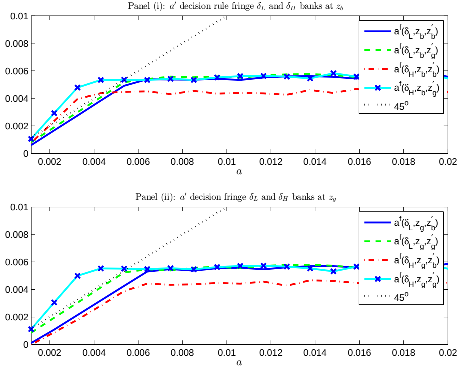
Fringe Bank Exit Rule across $\delta' s$



- Fringe banks with low assets are more likely to exit, particularly if they are small δ_L.

Return

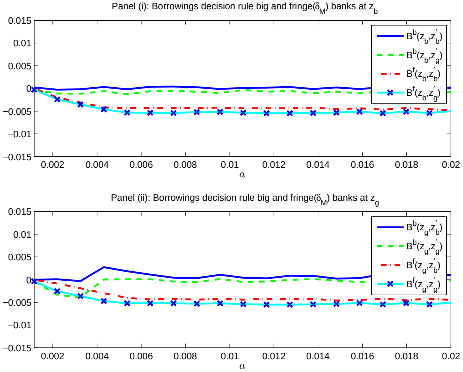
Fringe Banks $a^{f'}$ (different $\delta' s$)



- The smallest fringe bank is more cautious than the largest fringe bank.

Return

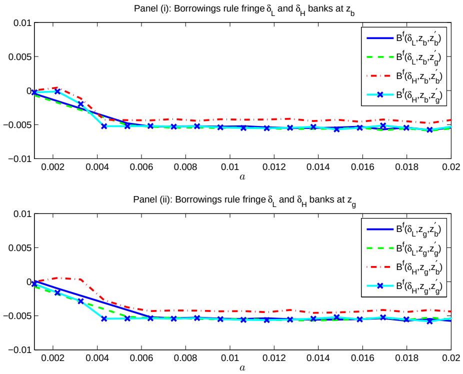
Big Bank and Median Fringe B^{θ}



- The only type bank which borrows short term to cover any deficient cash flows is the big bank at low asset levels when $z = z_g$ and $z' = z_b$.

Return

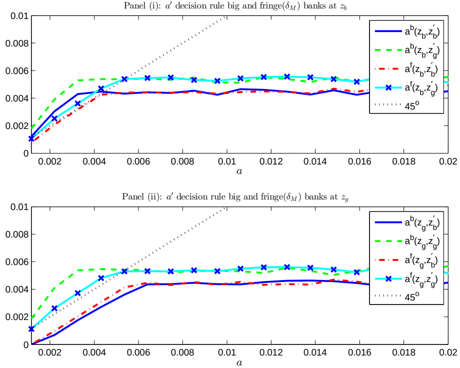
Fringe Banks B^f (different $\delta's$)



- the largest fringe stores significantly less as the economy enters a recession.

Return

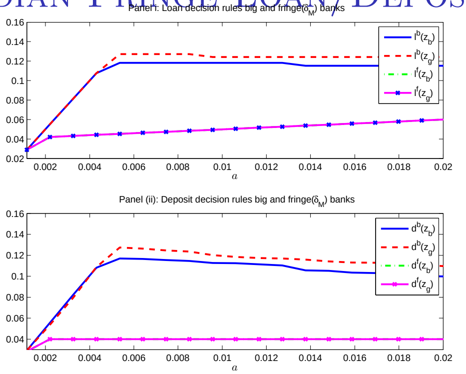
Big and Median Fringe Buffer Choice $a^{\theta'}$



- $a^{\theta'} < a^{\theta}$ implies that banks are dis-saving
- In general, when starting assets are low and the economy enters a boom, banks accumulate future assets.

Return

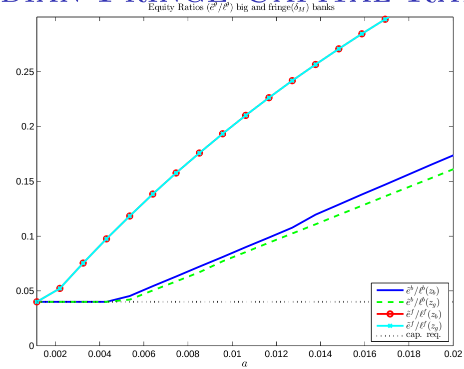
Big and Median Fringe Loan/Deposit



- If the dominant bank has sufficient assets, it extends more loans/accepts more deposits in good than bad times.
- However at low asset levels, loans are constrained by level of capital
- Loans are always increasing in asset levels for small banks.

Return

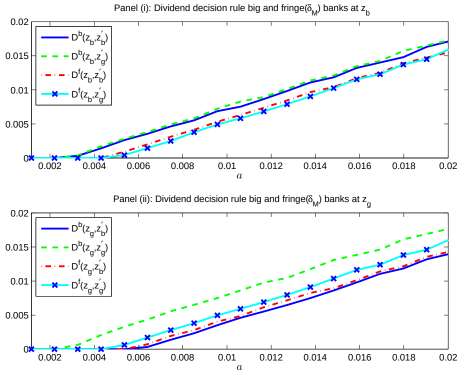
Big and Median Fringe Capital Ratios $\tilde{e}^{\theta}/\ell^{\theta}$



- Recall that $\tilde{e}^{\theta}/\ell^{\theta} = (\ell^{\theta} + \tilde{a}^{\theta'} - d^{\theta})/\ell^{\theta}$
- The capital requirement is binding for the big bank at low asset levels but at higher asset levels becomes higher in recessions relative to booms.

Return

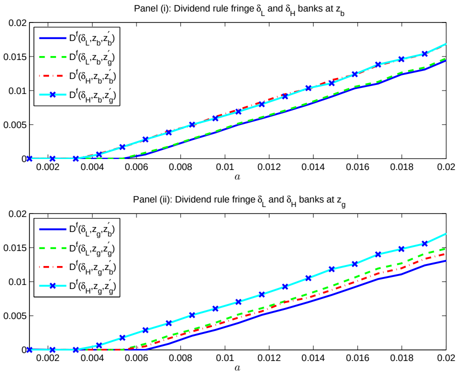
Big Bank and Median Fringe Dividends



- Strictly positive payouts arise if the bank has sufficiently high assets.
- There are bigger payouts as the economy enters good times.

Return

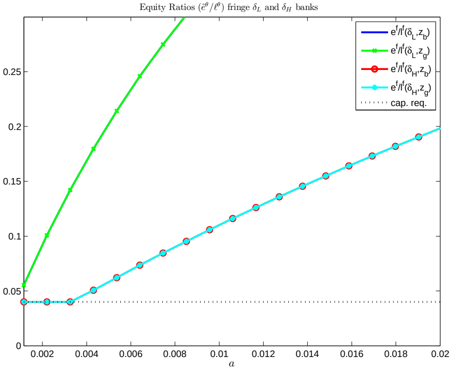
Fringe Banks Dividends (different δ's)



- The biggest fringe banks are more likely to make dividend payouts than the smallest fringe banks.

Return

Fringe Capital Ratios $\tilde{e}^f/\ell^f$ (across $\delta' s$)



- Big fringe banks behave like the dominant bank. Return

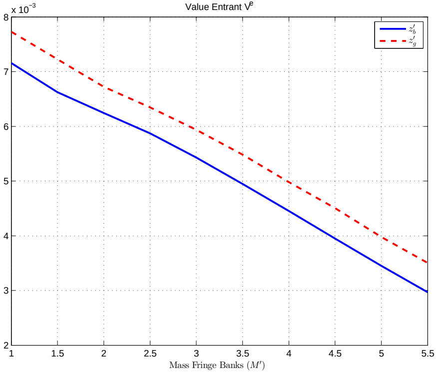
Equilibrium Threshold Properties ▸ Return

Bank behavior characterized by thresholds:

- If the agg. state turns bad, exit by fringe banks at low a^θ, no exit by big banks on equilibrium path. ▸ Details
- If a^θ is low, banks save provided that future agg. state is not bad, and dissave otherwise (leads to well-defined upper asset bound). ▸ $a^{\theta'}$
- Capital Ratio binds only for bigger banks when a^θ is low. ▸ $\tilde{e}^\theta / \ell^\theta$
- Big bank loan supply constrained by capital requirement when $\tilde{a}^\theta$ is low, otherwise chooses unique max. ▸ ℓ^θ and d^θ
- No dividends paid when a^θ is low. ▸ Dividends

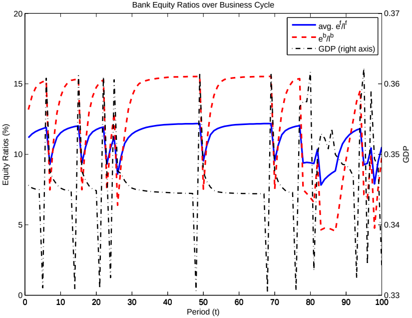
Value Fringe Potential Entrant

Return



- The benefit of entering is smaller the more competition a bank faces.
- The value of entry is higher in good times (procyclical entry).

Capital Ratios over the Business Cycle



- Capital Ratios are countercyclical because loans are more procyclical than "precautionary" asset choices. Return

Test 2: The Bank Lending Channel

Return

Question: Kashyap and Stein (2000) ask "Is the impact of monetary policy on lending behavior stronger for banks with less liquid balance sheets, where liquidity is measured by the ratio of securities to assets?

- They find strong evidence in favor of this bank lending channel.
- We analyze a reduction in r^B (overnight borrowing rate) from 1.2% to 0% on a pseudo-panel of banks from the model.
- In the first stage, we estimate the following cross-sectional regression for each t:

$$\Delta L_{it} = a_0 + \beta_t B_{it-1} + u_t$$

where $\Delta L_{it} = \frac{\ell_{it} - \ell_{it-1}}{\ell_{it-1}}$, and $B_{it} = \frac{a'_{it}}{(a'_{it} + \ell_{it})}$ is the measure of liquidity

- Then use the sequence of β_t to estimate the second stage as follows

$$\beta_t = b_0 + b_1 \Delta \text{output}_t + \phi dM_t$$

where dM_t is a dummy variable that equals 1 if $r_t^B = 0\%$

The Bank Lending Channel - cont. ▸ Return

Question: Kashyap and Stein ask "Is the impact of monetary policy on lending behavior stronger for banks with less liquid balance sheets, where liquidity is measured by the ratio of securities to assets?

Sample	Bottom 99%	Bottom 92%
	β_t	β_t
Monetary Policy: dM_t	-0.929	-1.177
s.e.	0.2575***	0.2521***
Δoutput$_t$	2.53	2.306
s.e.	0.619***	0.586***
R^2	0.35	0.46

Note: *** significant at 1% level

- Our results are consistent with those presented in Kashyap and Stein.
- We find that $\frac{\partial\left(\frac{\partial L_{it}}{\partial B_{it}}\right)}{\partial M_t} < 0$ and that $\frac{\partial L^3_{it}}{\partial B_{it}\partial M_t \partial size_{it}} > 0$ (i.e. the mechanism at play is stronger for the smallest size banks).

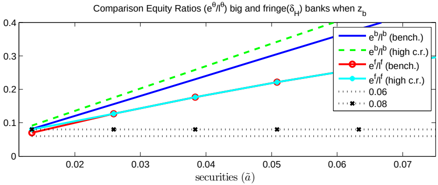
Monetary Policy and Bank Lending

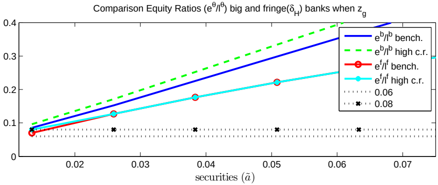
Return

	Benchmark	Lower r^B	Δ (%)
Capital Ratio Top 1%	4.23	5.43	28.43
Capital Ratio Bottom 99%	13.10	13.39	2.19
Entry/Exit Rate (%)	1.547	1.904	23.09
Loans to Asset Ratio Top 1%	96.31	73.84	-23.33
Loans to Asset Ratio Bottom 99%	93.47	43.47	-53.49
Measure Banks 99%	2.83	11.63	311.07
Loan mkt sh. 99% (%)	53.93	45.69	-15.28
Loan Supply	0.229	0.344	50.19
L^s to Int. Output ratio (%)	89.47	89.23	-0.26
Loan Interest Rate (%)	6.79	3.85	-43.23
Borrower Project (%)	12.724	12.652	-0.57
Default Frequency (%)	2.69	1.61	-40.02
Avg. Markup	111.19	35.20	-68.34
Int. Output	0.26	0.39	50.58
Taxes/Output (%)	0.07	0.09	24.99

- Reducing the cost of funds increases the value of the bank resulting in a large influx of fringe banks
- Reduction in borrowing cost relaxes ex-post constraint: higher big bank loan supply, lower interest rates and lower default rates.

Higher Capital Requirements and Equity Ratios





- Major impact for big bank: higher concentration and profits allow the big bank to accumulate more securities.
- Fringe banks with very low level of securities are forced to increase its capital level resulting in a lower continuation value (everything else equal).

Return

Capital Requirement Counterfactual

Question: How much does a 50% increase of capital requirements affect outcomes? ▸ Return ▸ Table No Cap. Requirements

Moment (%)	Benchmark ($\varphi = 4\%$)	Higher Cap. Req. ($\varphi = 6\%$)	Change (%)
Capital Ratio Top 1%	4.23	6.09	44.19
Capital Ratio Bottom 99%	13.10	15.67	19.57
Entry/Exit Rate (%)	1.547	0.843	-45.54
Sec. to Asset Ratio Top 1%	3.68	5.57	51.19
Sec. to Asset Ratio Bottom 99%	6.52	7.00	7.36
Measure Banks 99%	2.83	2.41	-14.64
Loan mkt sh. 99% (%)	53.93	52.15	-3.30
Loan Supply	0.229	0.209	-8.71
L^s to Int. Output ratio (%)	89.47	89.54	0.08
Loan Interest Rate (%)	6.79	7.30	7.56
Borrower Project (%)	12.724	12.742	0.14
Default Frequency (%)	2.69	3.01	12.19
Avg. Markup	111.19	123.51	11.08
Int. Output	0.26	0.23	-8.78
Taxes/Output (%)	0.07	0.03	-58.97

The Role of Imperfect Competition

▸ Return

Question: How much does imperfect competition affect capital requirement counterfactual predictions?

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- Without big banks $\rightarrow$ higher mass M of fringe banks and higher loan supply $\rightarrow$ interest rates drop 50 basis points. ▸ Table
- Lower profitability leads to lower entry (-50%) but higher total exits ($M \cdot x$) $\rightarrow$ higher taxes/output.

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- Some correlations are inconsistent with the data; for example, strong countercyclicality of the default frequency (10 times the data) results in procyclical loan interest returns and markups. ▸ Table

Countercyclical Capital Requirements ▸ Return

Question: What if capital requirements are higher in good times (i.e. $\varphi = 0.04) \rightarrow (\varphi(z_b) = 0.06, \varphi(z_g) = 0.08))$? ▸ Table

- Bank exit/entry drops to nearly zero and 60 basis point rise in interest rates.
- Intermediated output drops 10% but taxes/output drop 90%.
- Lower fringe bank entry → 50% drop in small bank market share (more concentrated industry).

Capital Requirements and Competition

Question: How much does imperfect competition affect capital requirement counterfactual predictions? Return

Moment (%)	Benchmark Model $\varphi = 4\%$	Benchmark Model $\varphi = 6\%$	Benchmark Model Δ (%)	Perfect Competition $\varphi = 4\%$	Perfect Competition $\varphi = 6\%$	Perfect Competition Δ (%)
Capital Ratio (%)	13.10	15.667	19.57	9.92	11.77	18.64
Entry/Exit Rate (%)	1.55	0.84	-45.54	0.81	0.69	-14.81
Measure Banks	2.83	2.414	-14.64	5.36	5.13	-4.13
Loan Supply	0.23	0.21	-8.71	0.25	0.24	-2.46
Loan Int. Rate (%)	6.79	7.30	7.56	6.27	6.43	2.50
Borr. Proj. (%)	12.724	12.742	0.14	12.71	12.71	0.04
Def. Freq. (%)	2.69	3.01	12.19	2.44	2.51	3.07
Avg. Markup	111.19	123.51	11.08	113.91	118.58	4.11
Int. Output	0.26	0.23	-8.78	0.28	0.27	-2.47
L^s to output (%)	89.47	89.54	0.08	89.42	89.43	0.02
Taxes/output (%)	0.07	0.03	-58.97	0.126	0.107	-15.20

- Policy effects are muted in the perfectly competitive environment.

Imperfect Competition and Volatility

Coefficient of Variation (%)	Benchmark Model	Perfect Competition ($\uparrow \Upsilon^b$)	Change (%)
Loan Interest Rate	4.92	1.78	-63.78
Borrower Return	6.99	6.17	-11.75
Default Frequency	2.08	2.15	3.36
Int. Output	7.46	2.09	-72.03
Loan Supply	7.208	1.127	-84.37
Capital Ratio Fringe	13.83	12.07	-12.70
Measure Banks	0.79	1.90	139.71
Markup	4.73	1.56	-67.02
Loan Supply Fringe	3.13	1.127	-64.05

Return

Imperfect Competition and Business Cycle Correlations

	Benchmark	Perfect Comp.	data
Loan Interest Rate r^L	-0.96	-0.36	-0.18
Exit Rate	-0.07	-0.16	-0.25
Entry Rate	0.01	-0.19	0.62
Loan Supply	0.97	0.61	0.58
Deposits	0.95	0.02	0.11
Default Frequency	-0.21	-0.80	-0.08
Loan Interest Return	-0.47	0.65	-0.49
Charge Off Rate	-0.22	-0.80	-0.18
Price Cost Margin Rate	-0.47	0.65	-0.47
Markup	-0.96	0.29	-0.19
Capital Ratio Top 1%	-0.16	-	-0.75
Capital Ratio Bottom 99%	-0.03	-0.05	-0.12

Return

The role of Capital Requirements

Question: What if there are no capital requirements? Return

	Benchmark Model			Perfect Competition		
Moment	$\varphi = 4\%$	No CR	Δ (%)	$\varphi = 4\%$	No CR	Δ (%)
Cap. ratio top 1%	4.23	0.19	-87.41	-	-	-
Cap. ratio bottom 99%	13.10	15.73	20.05	9.92	6.67	-32.71
Entry/Exit Rate (%)	1.55	4.81	210.75	0.81	1.04	28.50
Loan mkt sh. 99% (%)	53.93	87.44	62.14	100	100	0.0
Measure Banks	2.83	4.54	60.54	5.36	5.32	-0.68
Loan Supply	0.23	0.16	-28.44	0.25	0.24	-3.06
Loan Int. Rate (%)	6.79	8.47	24.83	6.27	6.47	3.11
Borrower Proj. (%)	12.72	12.81	0.67	12.71	12.71	0.04
Default Freq. (%)	2.69	4.74	76.39	2.44	2.53	3.79
Avg. Markup	111.19	177.73	59.84	113.91	119.74	5.12
Int. Output	0.26	0.18	-28.57	0.28	0.27	-3.08
L^s to output ratio (%)	89.47	89.63	0.18	89.42	89.44	0.02
Taxes/GDP (%)	0.07	0.11	55.80	12.60	17.22	36.72

- No capital requirement relaxes ex-ante constraint: higher entry/exit rate, larger measure of small banks, big bank acts strategically lowering its loan supply leading to higher interest rates and higher default rates.

Countercyclical Capital Requirements

Question: What if capital requirements are higher in good times?

	Benchmark ($\varphi = 0.04$)	Countercyclical CR ($\varphi(z_b) = 0.06$, $\varphi(z_g) = 0.08$)	Δ (%)
Capital Ratio Top 1%	4.23	25.13	494.65
Capital Ratio Bottom 99%	13.10	12.66	-3.38
Entry/Exit Rate (%)	1.547	0.001	-99.94
Measure Banks 99%	2.83	1.55	-45.33
Loan mkt sh. 99% (%)	53.93	26.47	-50.91
Securities to Asset Ratio Top 1%	3.68	21.09	472.48
Securities to Asset Ratio Bottom 99%	6.52	25.51	291.26
Loan Supply	0.229	0.206	-10.08
L^s to Int. Output ratio (%)	89.47	89.53	0.07
Loan Interest Rate (%)	6.79	7.38	8.76
Borrower Project (%)	12.724	12.748	0.19
Default Frequency (%)	2.69	2.98	10.91
Avg. Markup	111.19	114.02	2.55
Int. Output	0.26	0.23	-10.11
Taxes/Output (%)	0.07	0.01	-87.57

Return