A Quantitative Model of Banking Industry Dynamics

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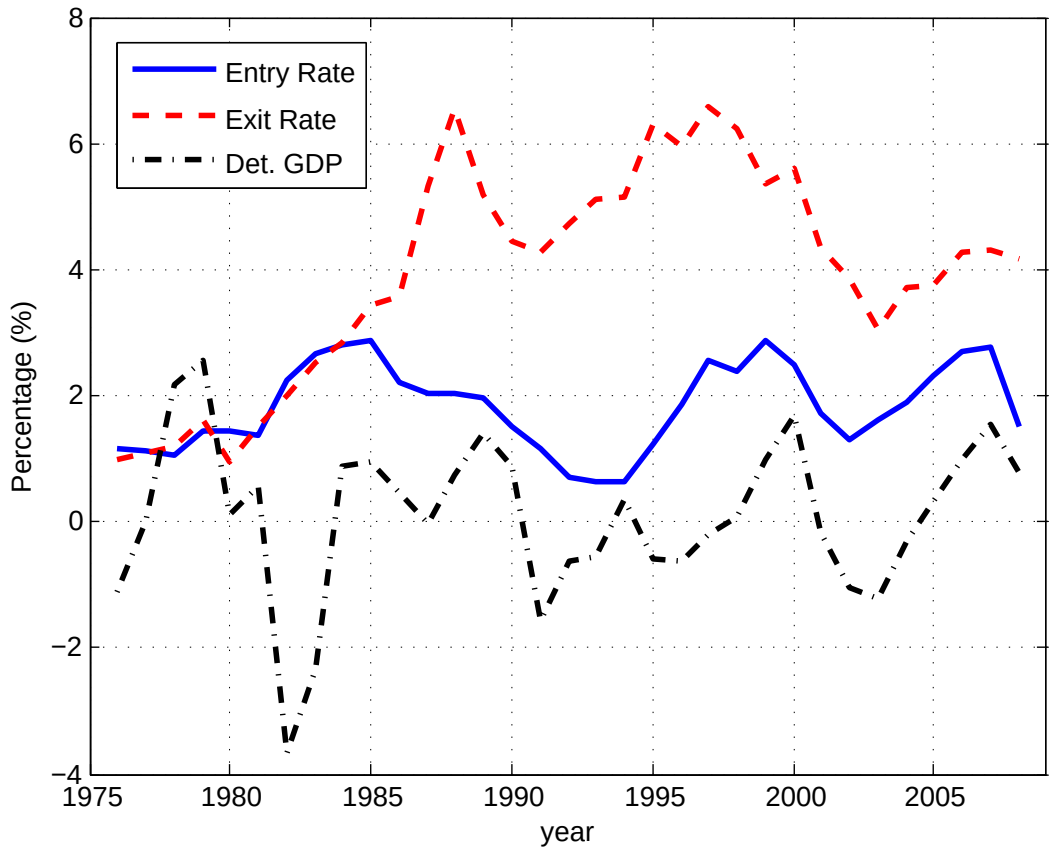
Questions

- How much does bank competition contribute to risk taking (as measured by bank insolvency/exit and economy-wide borrower default frequencies)?
- Are crises less likely in more concentrated banking systems? Theoretical debate between proponents of the "concentration-stability" view (e.g. Allen and Gale) and the "concentration-fragility" view (e.g. Boyd and DeNicolo).
  - Vast empirical literature trying to assess these questions (e.g. Beck, Demirguc-Kunt, and Levine (2003) run prob(crisis|concentration,controls)) with mixed results.
- What are the costs of policies to mitigate big bank failure?

Outline

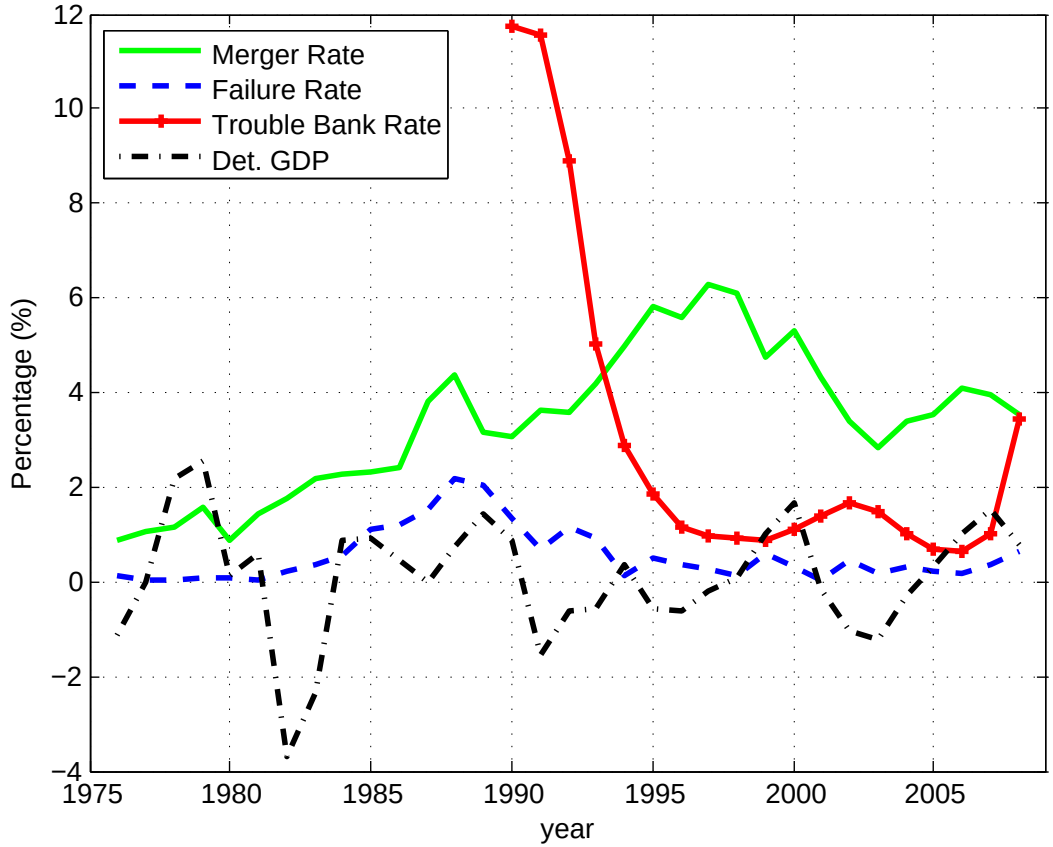
1. Document U.S. Commercial Banking Facts from Balance sheet and Income Statement Panel Data as in Kashyap and Stein (2000).
2. A Structural Model of the Banking Industry Dynamics
   - Underlying Static Cournot Model with Exogenous Distribution as in Allen & Gale (2000), Boyd & De Nicolo (2005).
   - Quantitative Theory:
     - Most quantitative models (e.g. Diaz-Gimenez, et. al. (1992), Gertler & Kiyotaki (2009)) assume perfect competition & CRS $\rightarrow$ indeterminate bank size distribution.
     - Cournot Competition with a Fringe: Ericson & Pakes (1995)/ Gowrisankaran & Holmes (2004)
     - Entry & exit across the business cycle generates endogenous bank size distribution.
3. Calibration to long-run averages of bank industry data.
4. Results:
   - Test against business cycle properties, moments by bank size and empirical studies linking banking crisis/default and concentration.
   - Counterfactuals: Bank Competition, Branching Restrictions, Too-Big-to-Fail, Lower Cost of Loanable Funds.

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) =(0.62,0.14) after 1990 (deregulation)

Exit Rate Decomposed



- Correlation of GDP with (Failure, Troubled, Mergers) =(-0.25, -0.49, 0.21) after 1990

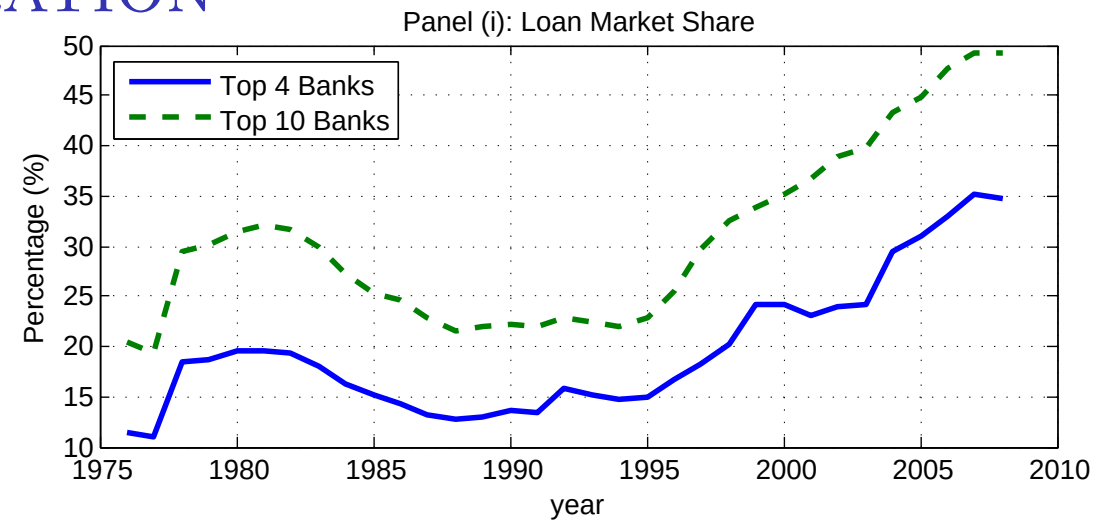
Entry and Exit by Bank Size

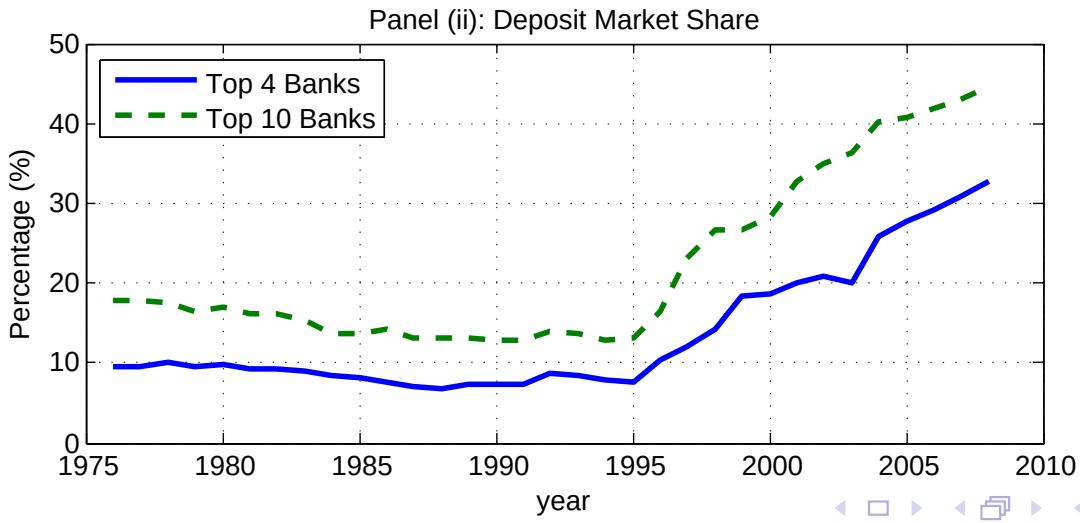
Fraction of Total x, accounted by:	x Entry	Exit	Exit/Merger	Exit/Failure
Top 10 Banks	0.00	0.09	0.16	0.00
Top 1% Banks	0.33	1.07	1.61	1.97
Top 10% Banks	4.91	14.26	16.17	15.76
Bottom 99% Banks	99.67	98.93	98.39	98.03
Total Rate	1.71	3.92	4.57	1.35

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

Increase in Loan and Deposit Market Concentration





Measures of Concentration in 2008

Measure	Deposits	Loans
Percentage of Total in top 4 Banks (C_4)	32.7	34.7
Percentage of Total in top 10 Banks	44.5	49.2
Percentage of Total in top 1% Banks	69.4	74.3
Percentage of Total in top 10% Banks	86.4	88.9
Ratio Mean to Median	10.5	9.8
Ratio Total Top 10% to Top 50%	91.2	90.3
Gini Coefficient	.91	.90
HHI : Herfindahl Index (National) (%)	4.9	3.8
HHI : Herfindahl Index (by MSA) (%)	19.6	20.7

Note: Total Number of Banks 7,092. Top 4 banks are: Bank of America, Citibank, JPMorgan Chase, Wachovia.

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

Measures of Banking Competition

Moment (%)	Value	Std Error	Corr w/ GDP
Net interest margin	4.59	0.06	-0.47
Markup	70.91	7.25	-0.17
Lerner Index	36.23	1.97	-0.19
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 due to more competition in good times.
- New amplification mechanism - Countercyclical markup means loan interest rates lower than constant markup case and hence more loans during upturns.

▸ Definitions ▸ Figures

Average Loan Returns and Volatility by Bank Size

Loan Returns ($p.r^L$)	Avg.	Std. Dev.	Corr. with GDP
Top 10 Banks	$5.30^{*,\dagger}$	$1.28^{*,\dagger}$	-0.43*
Top 1% Banks	$5.58^{\dagger}$	$1.37^{\dagger}$	$-0.52^{\dagger}$
Bottom 99% Banks	6.15	1.42	-0.46

Note: * Denotes statistically significant difference with Top 1% value.

† Denotes statistically significant difference with Bottom 99% value.

- Higher volatility of small bank returns suggests less diversification
  - ▸ Portfolio Composition by Bank Size
- Liang and Rhoades (1988) present evidence that geographic diversification lowers bank risk.
- Real estate becoming more important small banks
- Commercial and Industrial is more important for big banks

Fraction of Delinquent Loans by Bank Size

Moment (%)	Avg.	Std. Dev.	Corr. with GDP
Del. Fraction Top 10 Banks	$2.60^{*,\dagger}$	$0.82^{*,\dagger}$	-0.05^{*}
Del. Fraction Top 1% Banks	$1.83^{\dagger}$	$0.68^{\dagger}$	$-0.18^{\dagger}$
Del. Fraction Bottom 99% Banks	1.58	0.88	-0.03

- Evidence of higher fraction of delinquent loans for large banks could be due to selection effects (we do not observe small banks who exit due to excessive delinquencies).
- Countercyclical delinquency rates.

Non Interest Income and Expenses by Bank Size

	Non-Int Inc.	Non-Int Exp.	Net Exp.
Top 10 Banks (%)	$2.21^{*,\dagger}$	$4.64^{*,\dagger}$	$2.43^{*,\dagger}$
Top 1 % Banks (%)	$1.63^{\dagger}$	$3.95^{\dagger}$	$2.32^{\dagger}$
Bottom 99 % Banks (%)	0.81	2.87	2.06

- Non Interest Income, Non Interest Expenses (estimated from trans-log cost function) and Net Expenses are increasing in size.
- Selection of only low cost banks in the competitive fringe may drive the Net Expense pattern.

Definitions

Data Summary

- Entry is procyclical and Exit by Failure is countercyclical.
- Almost all Entry and Exit is by small banks.
- Loans and Deposits are procyclical (correl. with GDP equal to 0.58 and 0.10 respectively).
- Bank Concentration has been rising. Top 4 banks have 35% of loan market share.
- Signs of Non Competitive environment: Large Net Interest Margins, Markups, Lerner Index, Rosse-Panzar $H < 100$.
- Loan Returns, Margins, Markups, Delinquency Rates and Charge-offs are countercyclical.
- Small banks have higher loan returns, delinquency rates, volatility of returns and lower net non-interest expenses than big banks.

Model Overview

- Banks intermediate between large numbers of
  - risk averse households who can deposit at a bank with deposit insurance
  - risk neutral borrowers who demand funds to undertake risky projects.
- By lending to a large number of borrowers, a given bank diversifies risk that any particular household cannot accomplish individually.
- Simple bank balance sheet (assets=private loans, liablities=deposits).
- In the loan market, strategic (Cournot competition) MPE as in Ericson and Pakes (1995) augmented with competitive fringe as in Gowrisankaran and Holmes (2004).
- A nontrivial size distribution of dominant banks arises out of regional segmentation and entry/exit in response to shocks.

Agents

- 2 Regions $j \in \{e, w\}$.
- In each period and in each region,
  - a mass B of one period lived ex-ante identical borrowers are born
  - a large mass ($H >> B$) of one period lived ex-ante identical households are born (no deposit market competition)
- A small number of dominant banks (national and regional) and a large number of very small banks (a competitive fringe).

Stochastic Processes

- Aggregate Technology Shocks $z' \in \{z_b, z_g\}$ follow a Markov Process $F(z', z)$ with $z_b < z_g$
- Regional specific shocks $s' \in \{e, w\}$ also follow a Markov Process, $G(s', s)$ but negatively correlated across regions
- Conditional on z' and s', borrower failure is iid across individuals

Borrowers

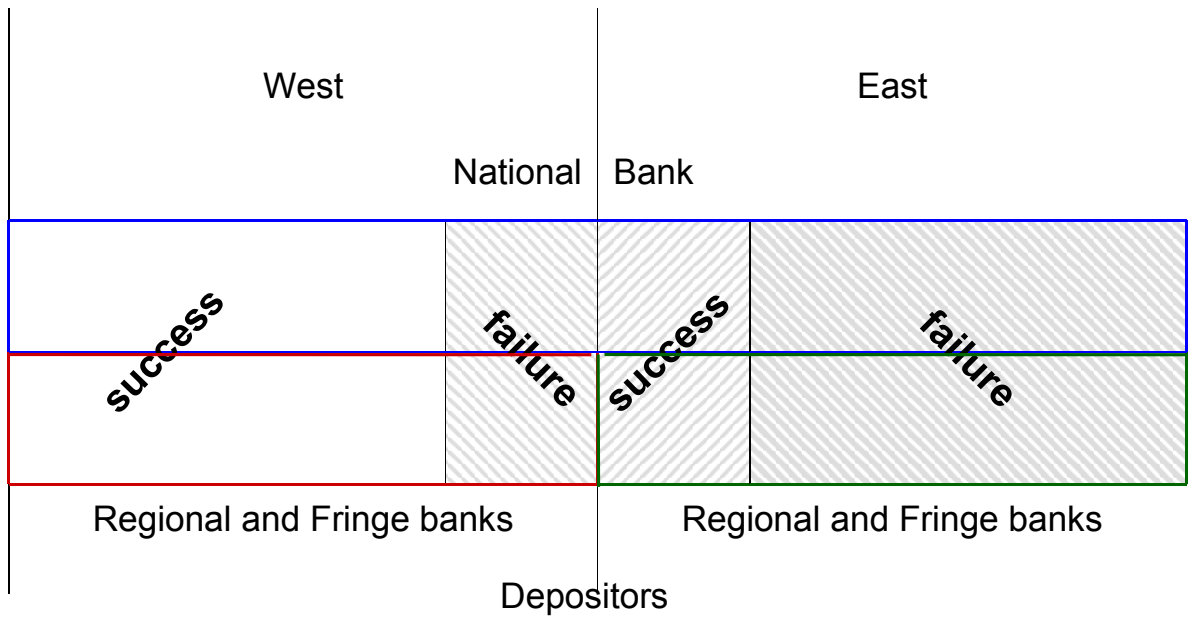
- Risk neutral borrowers in region j demand bank loans in order to fund a project/buy a house.
- Project requires one unit of investment at start of t and returns

$$\begin{cases} 1 + z_{t+1} R_t^j & \text{with prob } p^j(R_t^j, z_{t+1}, s_{t+1}) \\ 1 - \lambda & \text{with prob } 1 - p^j(R_t^j, z_{t+1}, s_{t+1}) \end{cases}. \quad (1)$$

- Borrowers choose R_t^j and have limited liability.
- Borrowers have an outside option (reservation utility) $\omega_t \in [\underline{\omega}, \overline{\omega}]$ drawn at start of t from distribution $\Upsilon(\omega_t)$.

Loan Market Essentials

Borrower chooses R^j	Receive	Pay	Probability
Success	$1 + z' R^j$	$1 + r^{L,j}(\mu, z, s)$	$p^j \quad (R^j, \; z', \; s')$
Failure	$1 - \lambda$	$1 - \lambda$	$1 - p^j \quad (R^j, \; z', \; s')$



Banks

- Three types of banks $\theta \in \{n, r, f\}$ for national, regional and fringe.
- Segmentation: National banks are geographically diversified but regional and fringe banks are restricted to a region $j \in \{e, w\}$.
- Banks face net costs: c^n, c^r and $c^f \sim \Xi(c)$.
- There is limited liability on the part of banks.
- Banks with negative profits have access to equity finance at cost ξ^θ per unit of funds raised to avoid exit if charter value is big enough.

Banks (cont.)

- Entry costs to create national and regional banks are denoted $\kappa^n \geq \kappa^r \geq 0$ and are normalized to zero for fringe banks.
- Fringe banks can enter only if net costs are higher than incumbents and are deposit capacity constrained $\overline{d}$.
- The banking industry state is denoted

$$\mu_t = \{N_t(n, \cdot), N_t(r, e), N_t(r, w), N_t(f, e), N_t(f, w)\}. \quad (2)$$

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).

Timing

At the beginning of period t,

1. Starting from state (μ_t, z_t, s_t), borrowers draw ω_t.
2. Dominant banks $\theta \in \{n, r\}$ choose how many loans $\ell_{i,t}(\theta, j)$ to extend and how many deposits $d_{i,t}(\theta, j)$ to accept.
3. Each fringe bank observes the total loan supply of dominant banks and all other fringe banks (that jointly determine the loan interest rate $r_t^{L,j}$) and simultaneously decide to extend loans or not. Borrowers in region j choose whether or not to undertake a project of technology R_t^j.
4. Return shocks z_{t+1} and s_{t+1} are realized, as well as idiosyncratic borrower shocks.
5. Exit and entry decisions are made in that order. Entry occurs sequentially (one bank after another).
6. Households pay taxes τ_{t+1} to fund deposit insurance and consume.

Incumbent Bank Decision Making

- $\sigma_{-i} = (\ell_{-i}, x_{-i}, e)$ denotes lending, exit, and entry strategies of all other banks.
- The end-of-period profits for bank i of type (θ, j) extending loans ℓ_i in region j is given by:

$$\pi_{\ell_i(\theta,j)}(\theta, j, c^\theta, \mu, z, s, z', s'; \sigma_{-i}) \equiv \Big\{ p^j(R, z', s')(1 + r^{L,j}) + (1 - p^j(R, z', s'))(1 - \lambda) - (1 + \overline{r}) - c^\theta \Big\} \ell_i(\theta, j).$$

- Differentiating w.r.t. ℓ_i

$$\frac{d\pi^j}{d\ell_i} = \overbrace{\left[p^j r^{L,j} - (1 - p^j)\lambda - \overline{r} - c^\theta \right]}^{(+) or (-)} + \overbrace{p^j \frac{dr^{L,j}}{d\ell}}^{(-)} \ell_i + \underbrace{\left\{ \frac{\partial p^j}{\partial R^j} \frac{\partial R^j}{\partial r^{L,j}} \frac{dr^{L,j}}{d\ell} (r^{L,j} + \lambda) \right\}}_{(+)} \ell_i$$

Incumbent National Bank Decisions

The value function of "national" incumbent bank i at the beginning of the period is given by

$$V_i(n,\cdot,\mu,z,s;\sigma_{-i}) = \max_{\{\ell_i(n,j)\}_{j=e,w}} E_{z',s'|z,s}\left[W_i(n,\cdot,\mu,z,s,z',s';\sigma_{-i})\right]$$

subject to loan market clearing (which implicitly defines a reaction function)

$$\sum_{\theta}\sum_{i=1}^{N(\theta,j)} \ell_i(\theta,j,\mu,s,z;\sigma_{-i}) - L^{d,j}(r^{L,j},z,s) = 0, \forall j,$$

where

$$W_i(n,\cdot,\mu,z,s,z',s';\sigma_{-i}) = \max_{\{x\in\{0,1\}\}} \Big\{ W_i^{x=0}(n,\cdot,\mu,z,s,z',s';\sigma_{-i}), W_i^{x=1}(n,\cdot,\mu,z,s,z',s';\sigma_{-i}) \Big\}$$

Incumbent National Bank Decisions (cont.)

- Continuation Value:

$$W_i^{x=0}(n,\cdot,\mu,z,s,z',s';\sigma_{-i}) = \mathcal{D}_i + \beta V_i(n,\cdot,\mu',z',s';\sigma_{-i})$$

with cash flow defined as

$$\mathcal{D}_i = \begin{cases} \sum_j \pi_{\ell_i(n,j)}(n,j,c^n,\mu,z,s,z',s';\sigma_{-i}) & \text{if } \sum_j \pi_{\ell_i(n,j)}(\cdot) \geq 0 \\ \sum_j \pi_{\ell_i(n,j)}(n,j,c^n,\mu,z,s,z',s';\sigma_{-i})(1+\xi^b) & \text{if } \sum_j \pi_{\ell_i(n,j)}(\cdot) < 0 \end{cases}.$$

- Exit Value (limited liability):

$$W_i^{x=1}(n,\cdot,\mu,z,s,z',s';\sigma_{-i}) = \max\left\{0, \sum_j \pi_{\ell_i(n,j)}(n,j,c^n,\mu,z,s,z',s';\sigma_{-i})\right\}$$

Bank Entry

- Banks enter the market sequentially if the net present value exceeds the entry cost.
- A national bank chooses
  $e_i\left(n,\cdot,\{N^x(n,\cdot)+N^e(n,\cdot),\cdots\},z',s'\right)=1$ if

$$\beta V_i(n,\cdot,\{N^x(n,\cdot)+N^e(n,\cdot)+1,\cdots\},z',s';\sigma_{-i})-\kappa^n\geq 0. \quad (3)$$

Other Incumbents Decisions

- The problem of a "regional" incumbent bank is similar, except cash flows are confined to their region j, which makes them less diversified/more vulnerable to regional specific downturns.
- Fringe banks make their loan supply decision after dominant banks and take $r^{L,j}$ as given.
- The profit function is linear in $\ell_i(f,j)$ so the quantity constraint $\ell_i(f,j) \leq \bar{d}$ will in general bind the loan decision.
- Total loan supply by fringe banks in region j is given by a cutoff rule

$$L^s(f,j,\mu,z,s;\sigma_{-i}) = M\Xi(\bar{c}^j(\overset{-}{\mu},\overset{+}{z},\overset{+}{s};\sigma_{-i}))\bar{d}.$$

where $\bar{c}^j(\mu,z,s;\sigma_{-i})$ denotes the highest cost such that a fringe bank will choose to offer loans in region j.

▸ Figures

Markov Perfect Equilibrium

Properties

A pure strategy **Markov Perfect Equilibrium (MPE)** is a set of value functions and decision rules describing borrower and bank behavior for each region, loan interest rates $r^{L,j}$, a deposit interest rate $r^{D,j}$, an industry state μ, and a tax function $\tau(\mu, z, s, z', s')$ such that:

- Given $r^{L,j}$, borrower choice of project riskiness $R(r^{L,j}, z, s)$ is consistent with borrower optimization. Borrower Problem
- At $r^{D,j} = \overline{r}$, the household deposit participation constraint is satisfied. depositor problem
- Given $L^{d,j}(r^{L,j}, z, s)$, the value of the bank, loan decision rules, exit rules and entry decisions are consistent with bank optimization.
- The law of motion $\mu' = T(\mu)$ is consistent with bank entry and exit decision rules. T operator
- The interest rate $r^{L,j}(\mu, z, s)$ is such that the loan market clears: MC cond.
- Across all states (μ, z, s, z', s'), taxes cover deposit insurance.

Model Parameters Chosen Independent of Model

Parameter		Value	Target
Mass of Borrowers	B	1	Normalization
Mass of Households	H	$2B$	Assumption
Depositors' Preferences	σ	2	Participation Const.
Agg. Shock in Good State	z_g	1	Normalization
Agg. Shock in Bad State	z_b	0.969	Std. GDP
Transition Probability	$F(z_g, z_g)$	0.85	NBER data
Transition Probability	$F(z_b, z_b)$	0.35	NBER data
Deposit Interest Rate (%)	$\overline{r}$	0.86	Call Reports
Discount Factor	β	0.99	$(1+\overline{r})^{-1}$
Cost National Bank (%)	c^n	2.43	Call Reports
Cost Regional Bank (%)	c^r	2.32	Call Report

Model Parameters Chosen within Model

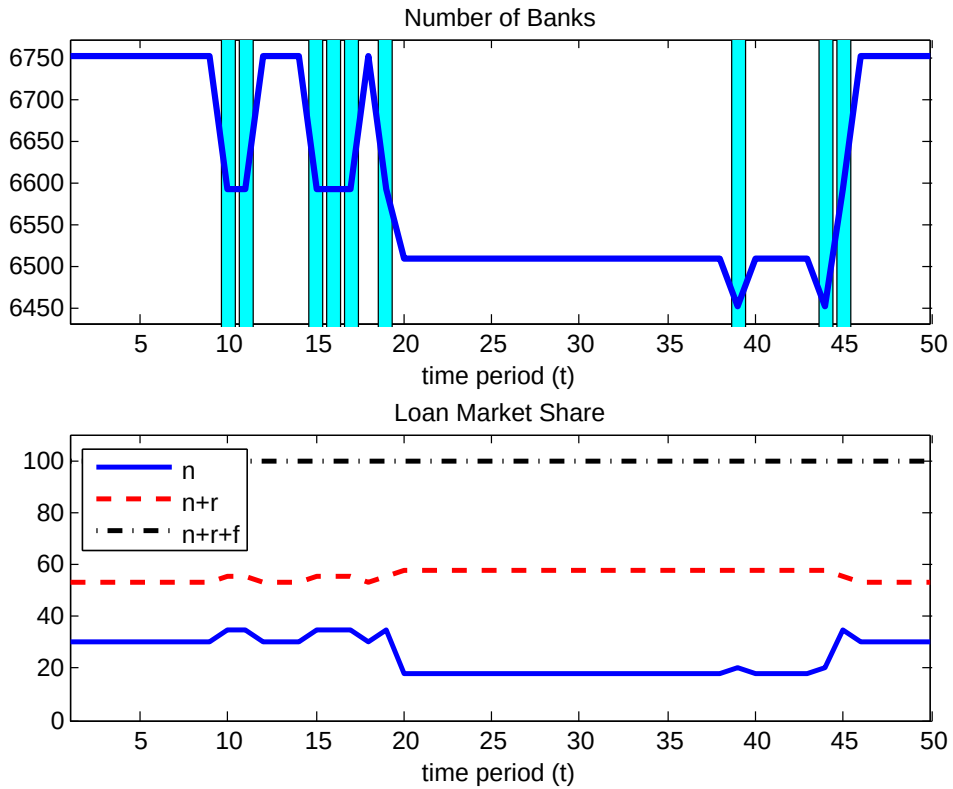
Parameter		Value	Targets
Weight Aggregate Shock	α	0.88	Default Frequency
Success Probability Fun.	b	3.77	Borrower Return
Success Probability Fun.	ψ	0.78	Bank Entry Rate
Volatility Entrep. Dist.	σ_ε	0.06	Loan Return
Loss Rate	λ	0.21	Charge off Rate
Max. Reservation Value	$\overline{\omega}$	0.23	Loan Return Top 10 to Top 1%
Regional Shock	$\overline{\phi}$	0.05	Profit Rate Top 10 to Top 1%
Persistence Reg. Shock	$\overline{G}$	0.96	Loan Ret. Top 1% to Bottom 99%
Entry Cost	$\kappa^n = \kappa^r$	0.29	Profit Rate Top 1% to Bottom 99%
Cost Fringe	μ_c	0.01	Mkt Share Top 1% Banks
Deposit Const. Fringe	$\overline{d}$	0.5e-04	Mkt Share Bottom 99%

▸ Functional Forms

Targeted Moments

Moment (%)	Model	Data
Default Frequency $1 - p(R^*, z', s')$	1.00	1.93
Borrower Return $p(R^*, z', s')(z'R^*)$	13.56	12.94
Loan Return $p(R^*, z', s')r^L$	5.95	5.27
Charge-Off Rate $(1 - p(R^*, z', s'))\lambda$	0.51	0.70
Entry Rate	2.75	1.80
Loan Return Top 10 to Top 1%	95.78	94.98
Profit Rate Top 10 to Top 1%	84.30	67.08
Loan Return Top 1% to Bottom 99%	99.45	90.73
Profit Rate Top 1% to Bottom 99%	27.80	60.75
Market Share Top 1%	35.47	30.73
Market Share Bottom 99%	43.11	38.71
Avg Non-Int Expense Bottom 99%	1.81	2.06

Banking Industry Evolution



- In most episodes, entry is procyclical and exit is countercyclical.
- Large swings correspond to entry or exit by regional banks following a switch in the regional shock.
- Periods of high (n) concentration following recessions raise interest rates and amplify the downturns.

Test I: Business Cycle Correlations

Variable Correlated with GDP	Model	Data
Loan Interest Rate r^L	-0.75	-0.18
Exit Rate	-0.41	-0.25
Entry Rate	0.01	0.62
Loan Supply	0.86	0.58
Deposits	0.86	0.11
Default Frequency	-0.43	-0.08
Profit Rate	0.19	0.21
Loan Return	-0.26	-0.49
Charge Off Rate	-0.60	-0.18
Price Cost Margin Rate	-0.28	-0.47
Lerner Index	-0.67	-0.17
Markup	-0.79	-0.19

- Though none of these moments were targetted, the model does a good job quantitatively with the business cycle correlations.

Test II: Moments by Bank Size

	Top 10		Top 1%		Bottom 99%	
Moment Average	Model	Data	Model	Data	Model	Data
Loan returns*	5.72	4.94	5.98	5.28	6.01	5.99
Bank profit rate*	2.24	1.65	2.66	2.46	9.55	4.05
Variance Return	0.19	0.75	0.30	1.80	0.35	2.34
Corr(ret,gdp)	-0.73	-0.11	-0.01	-0.18	-0.12	-0.17
Default frequency	0.95	2.64	0.77	1.54	1.13	1.58
Charge-off rate	0.50	0.93	0.46	0.92	0.53	0.55
Loan Interest rate	5.78	5.00	6.07	5.37	6.08	6.15
Net Interest Margin	4.87	4.14	5.14	4.52	5.15	5.20
Markup	44.29	46.97	58.54	65.78	100.20	112.75
Lerner Index	30.50	27.83	36.55	34.71	49.82	47.51

Note: Moments with * are included as calibration targets.

- The bigger the bank the lower the variance of returns (consistent with diversification)
- Model consistent with pattern of Markups (due to both returns being lower for big banks and costs being higher).

Test III: Empirical Studies of Banking Crises, Default and Concentration

Model	Logit	Linear
Dependent Variable	Crisis$_t$	Default Freq.$_t$
Concentration$_t$	-19.44	0.0197
	(-5.25)***	(18.88)***
GDP growth in t	-330.83	-1.561
	(-14.54)***	(-42.27)***
Loan Supply Growth$_t$	29.46	1.147
	(1.68)*	(23.51)***
R^2	0.76	0.53

Note: $t-$statistics in parenthesis.

- As in Beck, et. al. (2003), banking concentration (top 1% mkt share) is negatively related to the prob. of a crisis measured as default freq $> 10\%$, exit rate $> 2s.d.$,... (consistent with A-G).
- As in Berger et. al. (2008) we find that concentration is positively related to default frequency (consistent with B-D).

Effects of Bank Competition

Question: How much does increased competition raise or lower risk taking and bank exit? Compute a counterfactual where all entry costs κ rise by 6% (high enough to prevent entry of regional banks).

Moment	Benchmark	$\uparrow \kappa$	Change (%)
Default Frequency (%)	1.00	1.32	32.00
Entry/Exit Rate (%)	2.75	2.32	-15.64
Borrower Risk Taking R (%)	13.81	13.84	0.22
Loan Supply	0.76	0.58	-23.68
Loan Interest Rate (%)	6.01	7.82	30.12
Markup (%)	73.77	106.19	43.95
GDP	0.87	0.66	-24.14
Taxes/GDP (%)	0.03	0.02	-33.33

More concentration reduces bank exit (as in A-G) but increases default frequency (as in B-D).

Effects of Branching Restrictions

Question: How much does the removal of branching restrictions affect risk taking and bank exit? Compute a counterfactual where national bank entry costs κ^n rise 20% (high enough to prevent entry of national banks).

Moment	Benchmark	$\uparrow \kappa^n$	Change (%)
Default Frequency (%)	1.00	1.20	20.00
Entry/Exit Rate (%)	2.75	2.39	-13.09
Borrower Risk Taking R (%)	13.81	13.82	0.07
Loan Supply	0.76	0.71	-6.58
Loan Interest Rate (%)	6.01	6.64	10.48
Markup (%)	73.77	87.98	19.26
GDP	0.87	0.81	-6.90
Taxes/GDP (%)	0.03	0.03	0.00

Branching restrictions increase default frequency but reduce exit rates.

Too-Big-to-Fail

Question: How much does too big to fail affect risk taking?
Counterfactual where national bank is guaranteed a subsidy in states with negative profits. ▸ National Bank Problem

Moment	Benchmark	Too Big to Fail	Change (%)
Default Frequency (%)	1.00	0.99	-1.00
Entry/Exit Rate (%)	2.75	2.74	-0.36
Borrower Risk Taking R (%)	13.81	13.80	-0.07
Loan Supply	0.76	0.80	5.26
Loan Interest Rate (%)	6.01	5.57	-7.32
Markup	73.77	63.77	-13.56
GDP	0.87	0.91	4.60
Taxes/GDP (%)	0.03	0.04	33.33
Uncond. Prob. Bail Out	0.00	1.13	-
Max Cost Bailout / GDP (%)	0.00	2.00	-

- National bank increases exposure to region with high downside risk.
- Lower default and exit rates, higher GDP, Loan Supply but also Tax/GDP.

▸ more

Lowering the Cost of Loanable Funds

Question: How much does a lower cost of loanable funds affect risk taking and bank exit? Compute a counterfactual where compare the benchmark model where $\overline{r}$ is decreased from 0.89% to 0.

Moment	Benchmark	$\overline{r} = 0$	Change (%)
Default Frequency (%)	1.00	0.93	-7.00
Entry/Exit Rate (%)	2.75	2.23	-18.91
Borrower Risk Taking R (%)	13.81	13.80	-0.07
Loan Supply	0.76	0.80	5.26
Loan Interest Rate (%)	6.01	5.48	-8.82
Markup	73.77	95.67	29.69
Avg. Number Dominant Banks	2.77	2.77	-0.14
GDP	0.87	0.92	5.75
Taxes/GDP (%)	0.03	0.03	0.00

Concluding Remarks

- We provide a model where "big" national geographically diversified banks coexist in equilibrium with "smaller" regional and fringe banks that are restricted to a geographical area.
- One contribution of our model is that the number of banks is derived endogenously and varies over the business cycle.
- The model is consistent with business cycle correlations
- **Experiment 1:** More concentration reduces bank exit (as in A-G) but increases default frequency (as in B-D).
- **Experiment 2:** Branching restrictions increase default frequency but reduces exit.
- **Experiment 3:** While national banks increase exposure by making more loans with too big to fail, this can actually reduce default and bank exit.

Directions for Future Research

(I) Currently working (see C-D 2011) on extending the Bank Balance Sheet

- While loans are the largest component (about 67%) of a bank's balance sheet, another sizeable asset (about 22%) is securities or other interbank loans. ▸ Balance Sheet
- This adds another state variable (net assets) and complicates the computation, but allow us to conduct policy experiments with capital requirements as in Van Den Heuvel (2008).
- We can also study questions like those in Kashyap and Stein (2000); whether the impact of Fed policy on lending behavior is stronger for banks with less liquid balance sheets.

(II) Deposit Market Competition

- Add a distribution over outside options for depositors which will induce a supply of deposits that is sensitive to the deposit rate.

(III) Mergers

- Costly movement between bank type ($f \to r \to n$)

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

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. Expenses of premises and fixed assets (net of rental income). (excluding salaries and employee benefits and mortgage interest).
III. Goodwill impairment losses, amortization expense and impairment losses for other intangible assets.
IV. Other noninterest expense.

Return

Definition of Competition Measures

- The Net Interest Margin is defined as:

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

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

- The markup for bank is defined as:

$$\text{Markup}_{tj} = \frac{p_{\ell_{tj}}}{mc_{\ell_{tj}}} - 1 \tag{4}$$

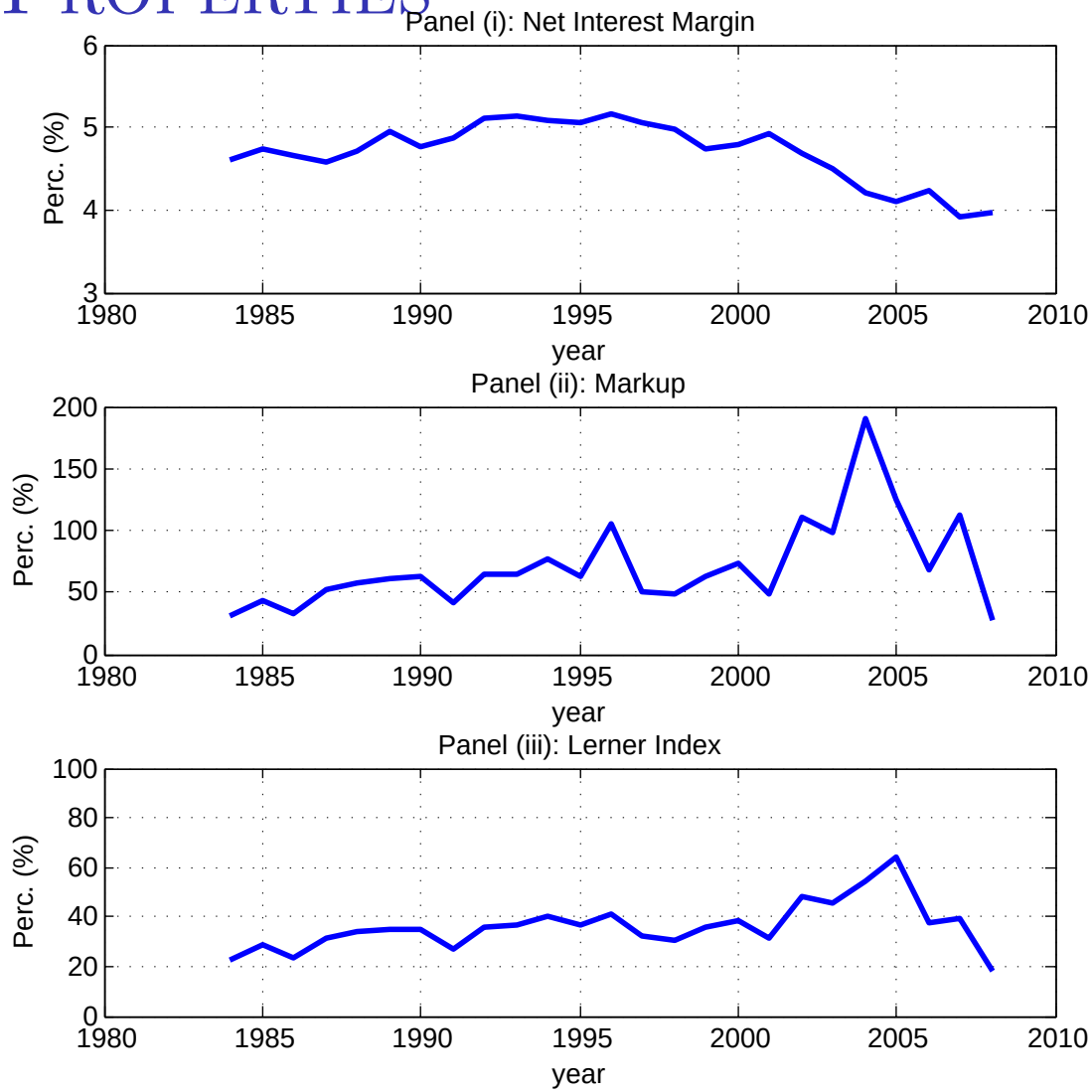
where $p_{\ell_{tj}}$ is the price of loans or marginal revenue for bank j in period t and $mc_{\ell_{tj}}$ is the marginal cost of loans for bank j in period t

- The Lerner index is defined as follows:

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

Return

Cyclical Properties



Return

Depositor Decision Making

- Besides depositing in a bank, households can choose to store in a riskless technology at rate r or match with a risky borrower.

◂ Figure Deposit / Loans

- If $r_t^D = \overline{r}$ households are indifferent between depositing at a bank in their region and using the storage technology.
- Given lump sum taxes $\tau(\mu, z, s, z', s')$, depositors choose not to match with an individual borrower if

$$U \equiv \sum_{z',s'} E_{z',s'|z,s} u(1 + \overline{r} - \tau(\mu, z, s, z', s')) >$$

$$\max_{\widehat{r} < r^{L,j}} \sum_{z',s'} E_{z',s'|z,s} \Big[p^j(\widehat{R}, z', s') u(1 + \widehat{r} - \tau(\mu, z, s, z', s'))$$

$$+ (1 - p^j(\widehat{R}, z', s')) u\left(1 - \lambda - \tau(\mu, z, s, z', s')\right) \Big] \equiv U^E. \quad (5)$$

i.e. if households are sufficiently risk averse.

◂ Return

Industry Evolution

- The law of motion $\mu' = T(\mu)$ is consistent with entry and exit decision rules:

$$\begin{aligned}\mu' \quad = \quad & \{N^x(n,\cdot) + N^e(n,\cdot), N^x(r,e) + N^e(r,e), \\ & N^x(r,w) + N^e(r,w), N^x(f,e) + N^e(f,e), N^x(f,w) + N^e(f,w)\}.\end{aligned}$$

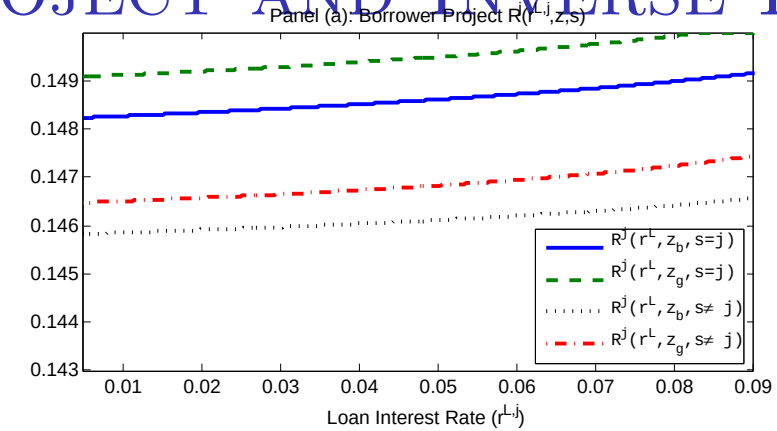
where the number of banks of type (θ, j) in the industry after exit is given by

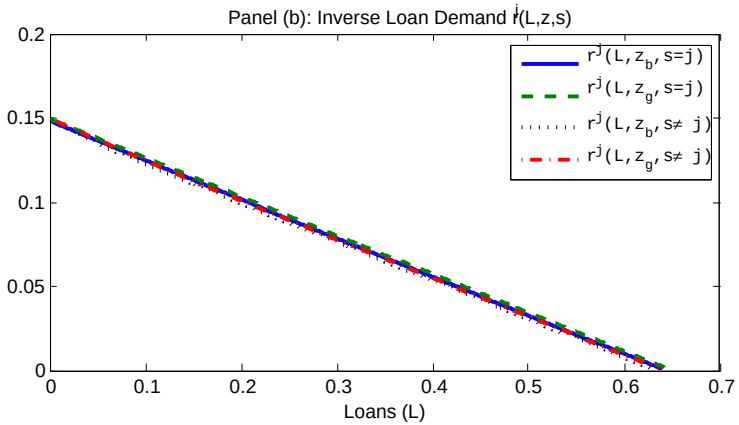
$$N^x(\theta,j) = \sum_{i=1}^{N(\theta,j)} \left(N(\theta,j) - x_i(\theta,j,\mu,z,s,z',s';\sigma_{-i})\right). \qquad (6)$$

and $N^e(\theta,j)$ denotes the number of entrants of type (θ,j).

- Return

Borrower Project and Inverse Loan Demand

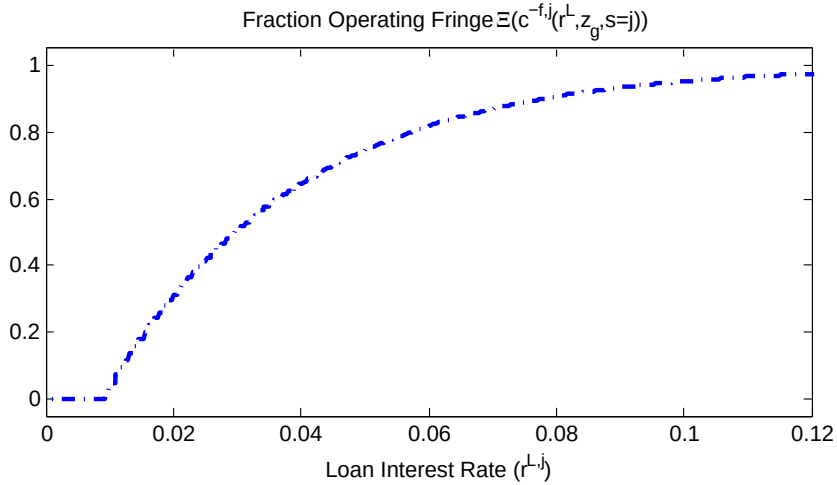


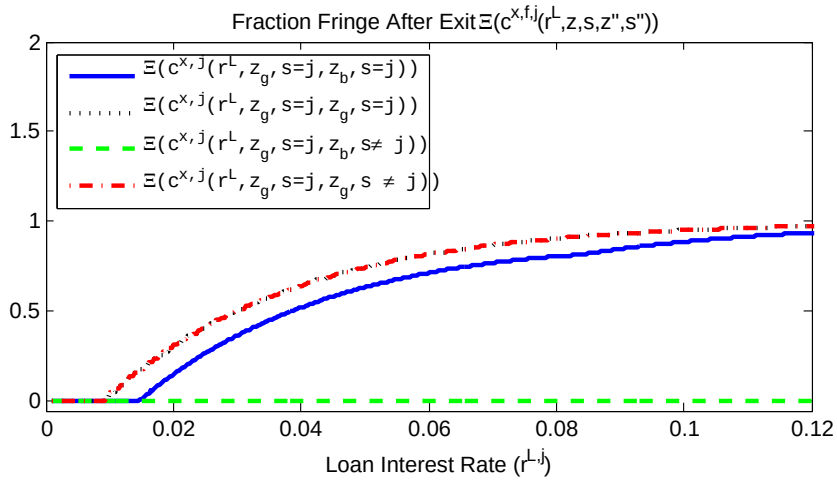


- First figure shows Boyd and De Nicolo's "risk shifting" effect that higher interest rates lead borrowers to choose more risky projects.

Return

Fringe Bank Decision Making - cont.





Return

Functional Forms

- Borrower outside option is distributed uniform $[0, \overline{\omega}]$.
- Fringe net costs are distributed exponential with parameter μ_c.
- For each borrower in region j, let $y^j = \alpha z' + (1-\alpha)\varepsilon - bR^\psi$ where ε is drawn from $N(\phi(s'), \sigma_\varepsilon^2)$ where we assume that if $s' = j$, $\phi(s') = \overline{\phi}$ and $\phi(s') = -\overline{\phi}$ otherwise.
- Define success to be the event that $y > 0$, so in states with higher z or higher ε_e success is more likely. Then

$$p^j(R, z', s') = 1 - \Phi\left(\frac{-\alpha z' + bR^\psi}{(1-\alpha)}\right) \tag{7}$$

where $\Phi(x)$ is a normal cumulative distribution function with mean $(\phi(s'))$ and variance σ_ε^2.

Return

Strategic Interaction

Compare decision rules on an equil. path of the benchmark dynamic vs. a static economy at $\mu = \{1, 1, 1, \cdot\}$, $z = z_g$, $s = e$:

	Loan Decision Rules $\ell(\theta, j, \mu, z, s)$ $(\mu = \{1, 1, 1, \cdot\}, z = z_g, s = e)$			
Model	$\ell(n, e, \cdot)$	$\ell(n, w, \cdot)$	$\ell(r, e, \cdot)$	$\ell(r, w, \cdot)$
Dynamic	0.018	0.121	0.177	0.128
Static	0.119	0.121	0.126	0.128
	Exit Rule $x(\theta, j, \mu, z, s, z' = z_b, s' = w)$			
Model	$x(n, \cdot)$		$x(r, e, \cdot)$	$x(r, w, \cdot)$
Dynamic	0		1	0
Static	1		1	0

Return

Equilibrium Properties: Off-the-Equilibrium-Path

- Exit occurs for national banks when it is a monopoly in both regions, we enter into a recession and the regional shock switches.
- Entry by a big bank happens if there is no other active big bank.

Return

Loan Supply $L^{s,j}(\mu, z)$

	$L^{s,e}(\mu, z, s)$		$L^{s,w}(\mu, z, s)$	
μ	(z_b, e)	(z_g, w)	(z_b, e)	(z_g, w)
$\{0, 1, 0, \cdot\}$	0.352	0.357	-	-
$\{0, 1, 1, \cdot\}$	0.352	0.357	0.346	0.352
$\{1, 0, 0, \cdot\}$	0.254	0.357	0.346	0.346
$\{1, 1, 0, \cdot\}$	0.392	0.376	0.346	0.346
$\{1, 1, 1, \cdot\}$	0.368	0.363	0.397	0.404

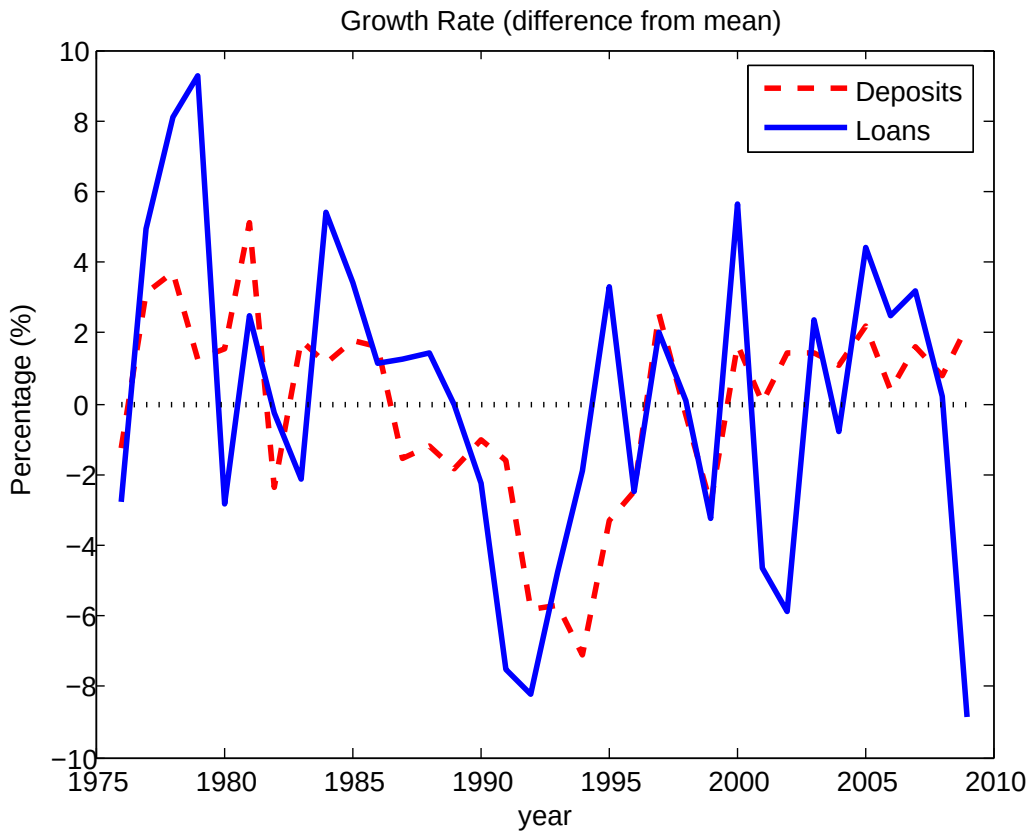
- Conditional on z, less concentration (national and regional) implies a higher loan supply.
- Aggregate loan supply is higher in booms.
- Return

Loan Interest Rate $r^{L,j}(\mu, z, s)$ (%)

	$r^{L,e}(\mu, z, s)$		$r^{L,w}(\mu, z, s)$	
μ	(z_b, e)	(z_g, w)	(z_b, e)	(z_g, w)
$\{0, 1, 0, \cdot\}$	6.65	6.72	-	-
$\{0, 1, 1, \cdot\}$	6.65	6.72	6.57	6.57
$\{1, 0, 0, \cdot\}$	8.90	6.72	6.57	6.72
$\{1, 1, 0, \cdot\}$	5.75	6.27	6.57	6.72
$\{1, 1, 1, \cdot\}$	6.29	6.57	5.41	5.39

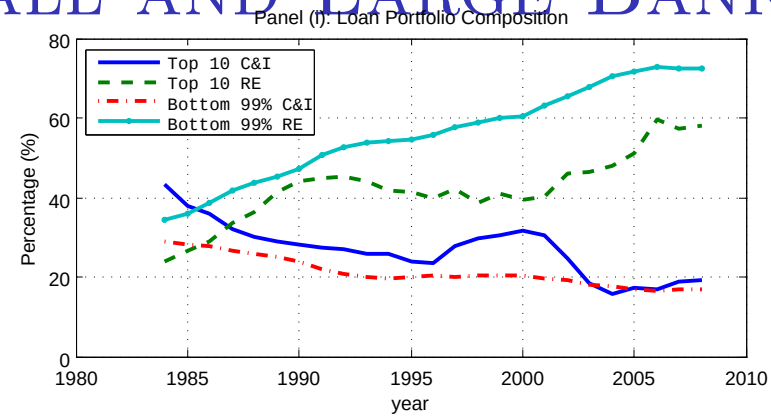
- More competition implies a lower interest rate.
- Along the equilibrium path, interest rates are countercyclical since the national bank charges a high interest rate in the region where it is a monopolist.
- Return

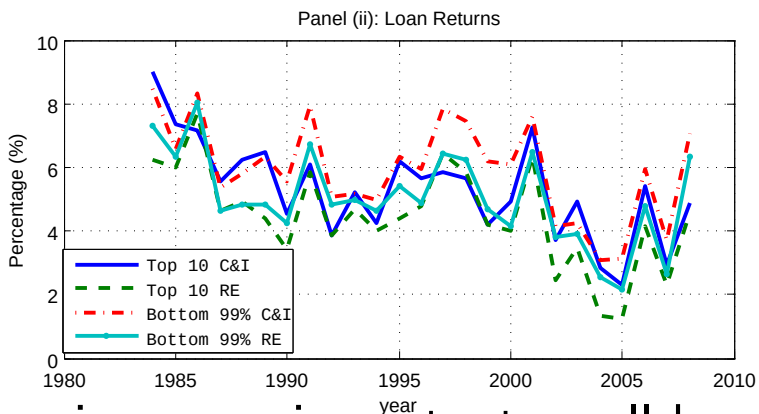
Deposit and Loan Growth Rates



Return

Portfolio Composition (Share of Total Loans) of Small and Large Banks





- Real estate becoming more important small banks
- Commercial and Industrial is more important for big banks

Return

Tradeoff Loan Returns

$$\frac{d(pr^L)}{dz} = \frac{dp}{dR}\frac{dR}{dr^L}\frac{dr^L}{dz}r^L + \frac{dr^L}{dz}p$$

where $\frac{dp}{dR} < 0$, $\frac{dR}{dr^L} > 0$, $\frac{dr^L}{dz} < 0$

Return

National Bank Problem under Too Big to Fail

- If realized profits for a national bank are negative, then the government covers the losses so that the bank stays in operation.

- The problem of a national bank becomes

$$V_i(n,\cdot,\mu,z,s;\sigma_{-i}) = \max_{\{\ell_i(n,j)\}_{j=e,w}} E_{z',s'|z,s}\Big[\sum_{j=e,w} \max\Big\{0, \pi_{\ell_i(n,j)}(n,j,c^n,\mu,z,s,z',s';\sigma_{-i})\Big\} + \beta V_i(n,\cdot,\mu',z',s';\sigma_{-i})\Big]$$

subject to

$$\sum_{\theta}\sum_{i=1}^{N(\theta,j)} \ell_i(\theta,j,\mu,s,z;\sigma_{-i}) - L^{d,j}(r^{L,j},z,s) = 0,$$

where $L^{d,j}(r^{L,j},z,s)$ is given in (11).

Return

Too-Big-to-Fail (cont.)

Table: Benchmark vs Too Big to Fail

	Loan Decision Rules $\ell(\theta, j, \mu, z_g, e)$ $(\mu = \{1, 1, 1, \cdot\}, z = z_g, s = e)$			
Model	$\ell(n, e, \cdot)$	$\ell(n, w, \cdot)$	$\ell(r, e, \cdot)$	$\ell(r, w, \cdot)$
Benchmark	0.018	0.121	0.177	0.128
Too Big To Fail	0.123	0.121	0.129	0.128

- Even though big bank failure doesn't occur on the equilibrium path in the benchmark, the possible loss of charter value is enough to induce national banks to lower loan supply in order to reduce exposure to risk.
- Higher loan supply with too big to fail may actually lower interest rates.

Return

Balance Sheet Data by Bank Size

Fraction Total Assets (%)	1990		2010	
	Bottom 99%	Top 1%	Bottom 99%	Top 1%
Cash	7.25	10.98	7.95	7.66
Securities	18.84	13.30	18.37	15.79
Loans	49.28	53.20	55.08	41.06
Deposits	69.70	62.75	64.37	56.02
Fed Funds and Repos	4.17	7.54	1.30	1.20
Equity Capital	6.20	4.66	9.94	10.66

Source: Call Reports.

- While Loans and Deposits are the most important components of the bank balance sheet, "precautionary holdings" of securities and equity capital are also important buffer stocks.

Return

Loan Market Clearing

$$B \cdot \int_{\underline{\omega}}^{\overline{\omega}} 1_{\{\omega \leq v(r^{L,j},z,s)\}} d\Upsilon(\omega) = \sum_{\theta} \sum_{i=1}^{N(\theta,j)} \ell_i(\theta, j, \mu, s, z; \sigma_{-i})$$

Return to Eq. Def.

Borrower Decision Making

- If a borrower in region j chooses to participate, then given limited liability his problem is to solve:

$$v(r^{L,j}, z, s) = \max_{R^j} E_{z',s'|z,s} p^j(R^j, z', s') \left(z' R^j - r^{L,j}\right). \quad (8)$$

- FOC w.r.t. R^j:

$$E_{z',s'|z,s}\Big\{ \overbrace{p^j(R, z', s')z'}^{(+)} + \overbrace{\frac{\partial p^j(R, z', s')}{\partial R}}^{(-)} \left[z' R - r^{L,j}\right] \Big\} = 0 \quad (9)$$

- The borrower chooses to demand a loan if

$$\begin{matrix} - & + & + \\ v(\quad r^{L,j}, & z, & s \quad) \geq \omega. \end{matrix} \quad (10)$$

- Aggregate demand for loans is given by

$$L^{d,j}(r^{L,j}, z, s) = B \cdot \int_{\underline{\omega}}^{\overline{\omega}} 1_{\{\omega \leq v(r^{L,j}, z, s)\}} d\Upsilon(\omega). \quad (11)$$

Figure Return to Eq. Def.

Equilibrium Properties

We find an equilibrium where:

- Bank failure and entry is more common among regional and fringe banks.
- Exit occurs for a regional bank when its regional shock turns bad during a recession.
  - Borrowers take on more risk in good times and project failure is more likely in bad states.
  - The national bank loan decision in good times lowers realized profits of regional banks enough to induce them to exit in bad realizations in order to become a regional monopoly next period (consistent with countercyclical markups) . strategic int.
- Entry by a regional bank happens if there is no active small bank in that region, the economy is in a boom and the region has a positive shock.

Off-the-Equilibrium-Path Behavior More Properties Return to Eq. Def.

Equilibrium Properties (cont.)

- Aggregate loan supply is higher in booms. ▸ $L^{s,j}(\mu, z, s)$
- Conditional on z, more competition (national and/or regional) implies a higher loan supply and a lower interest rate. ▸ $r^{L,j}(\mu, z, s)$
- Along the equilibrium path, interest rates are countercyclical since the big bank charges a high interest rate in the region where it is a monopolist.

◂ Return to Eq. Def.