The Geographic Flow of Bank Funding and Access to Credit: The role of branch networks & local market power

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Motivation / Context

- This paper is concerned with the **geographic flow of bank funds** from high supply to high demand locations.
- Without geographic frictions, the rate of return of the marginal loan would be the same across geographic markets.
- There are multiple **frictions to the flow of funds**, and these frictions depend on **geographic distance**:
  - Asymmetric information; - Monitoring costs.
- Frictions generate **geographic imbalances in provision of credit**, inequality and inefficiency.

Motivation / Context [2]

- **Interbank wholesale markets** can alleviate these frictions. They have their own imperfections, e.g., liquidity hoarding (Ashcraft et al., 2011; Acharya and Merrouche, 2012).

- Bank **branch networks** can facilitate the flow of funds between locations. **Coase:** trans. costs between branches of a bank smaller than trans. costs of using interbank markets.

- Two counterbalancing forces:
  - **Economies of scope** between deposits & loans (**home bias**)
  - **Local market power** (limited **pass-through**).

Our Empirical Questions

- We evaluate the extent to which **deposits and loans are geographically segregated** and study the role that **branch networks**, **economies of scope**, and **local market power** play in geographic flow of credit in the US banking industry.

- [1] How **branch networks** contribute the geographic flow of bank funds? Does credit in a county increase if its banks have branches in other counties with high supply of deposits?

- [2] How important is the **'home bias'** generated by **economies of scope** between deposits and loans?

- [3] What is the contribution of **local market power** to the geographic distribution of bank credit?

Our approach

- To determine the extent of geographic segregation we adapt techniques from labor/sociology to measure racial segregation.
- To investigate the factors that contribute to this segregation we propose and estimate estimate a structural **equilibrium model of oligopoly competition** in the deposit and loan markets in an economy characterized by **multiple geographic locations**.
- We estimate this model using a dataset on deposits and loans for US banks that improves over datasets in previous studies.
- The estimation of the model should deal with endogeneity problems.
- We: [A] measure the contribution of branch networks, economies of scope, and local market power; and [B] evaluate the effects of public policies on the geographic diffusion of bank funds.

Related Literature

- **Relationship between deposits and lending:** Gilje, Loutskina & Strahan (2013); Loutskina & Strahan (2015); Petkov (2016)

  - Use variation in deposits provided by catastrophic event
  - Our analysis extends to all counties, incorporates local market power, structural model and counterfactuals.

- **Structural models of bank competition:** Neven & Roller (1999); Dick (2007); Corbae & Erasmo (2013, 2014); Aguirregabiria, Clark & Wang (2016); Egan, Hortacsu & Matvos (2017)

  - Both deposits and loans and their link; multiple interconnected geographic markets.

Outline

[1] Data

[2] Descriptive analysis

[3] Model

[4] Estimation

[5] Counterfactuals

1. Data

Data Sources

- Main dataset is the result of merging two data sources at the **bank-county-year** level:
  - FDIC data on all **branches** and branch-level **deposits**.
  - **Mortgage** data from Home Mortgage Disclosure Act (HMDA)

- We construct a dataset with: **deposits**, amount of **new mortgages**, number of **branches** at the **bank-county-year** level.

- We merge this dataset with other data sources:
  - County socioeconomic characteristics from Census Bureau.
  - Bankruptcy cases at the county-year level by type.
  - Housing prices at the county-year level.

Working Sample

- We concentrate on the period from 1998-2010 (13 years).
- Our matched sample includes **6270 banks** in **3144 counties**: $\approx$ 1.5 M bank-county-year observations with either deposits$>$0 or new mortgages $>$0.
- Some data issues:
  - Mortgages from **non-depository institutions** in HMDA;
  - Only mortgages (70% all bank loans; 40% of assets);
  - No price data;
  - County as local market.

Summary Statistics: Bank level

Summary Statistics

Bank Level Statistics (48,531 bank-year obs.)

Variable	Mean	S. D.	Median
Number of branches	11.1	51.7	4.0
Number of counties with deposits>0	3.4	10.4	2.0
Number of counties with new loans>0	25.2	120.5	8.0
Total deposits (in million $)	623	3,927	148
Total new loans (in million $)	134	2,016	13

Summary Statistics: Bank level

Summary Statistics

County Level Statistics (40,736 county-year obs.)

Variable	**Mean**	**S. D.**	**Median**
Number of branches (per county)	13.2	32.9	4.0
Number of banks with deposits>0	4.1	6.3	2.0
Number of banks with loans>0	30.1	29.6	22.0
HHI market of deposits	3169	2074	2533
HHI market of new loans	868	810	632
Deposits per capita (in ,000 $)	14.3	12.0	12.4
New loans per capita (in ,000 $)	3.4	4.2	2.1
Income per capita (in ,000 $)	27.9	8.1	26.6

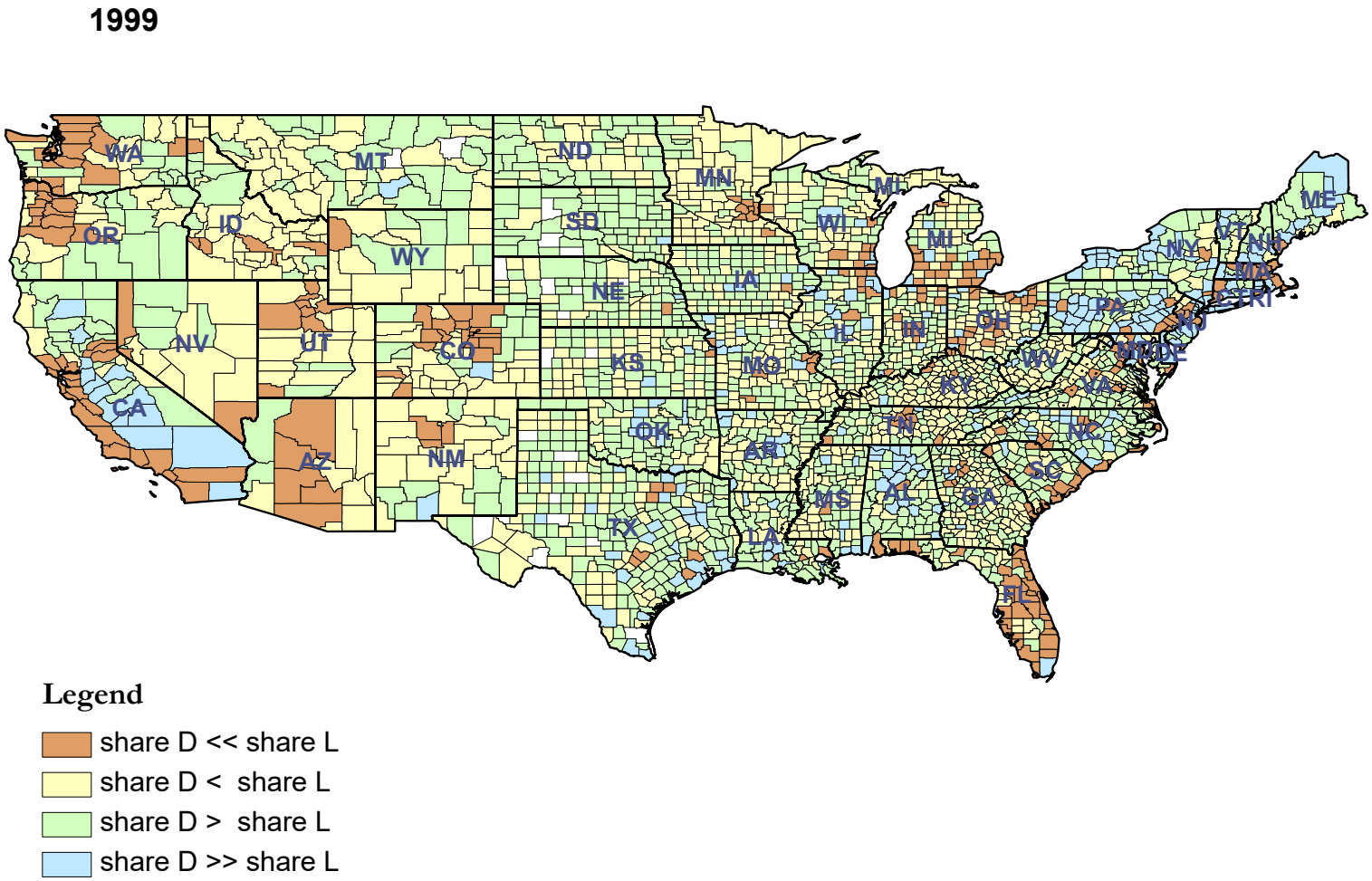
2. Descriptive Evidence

Counties Borrowing-Lending Position

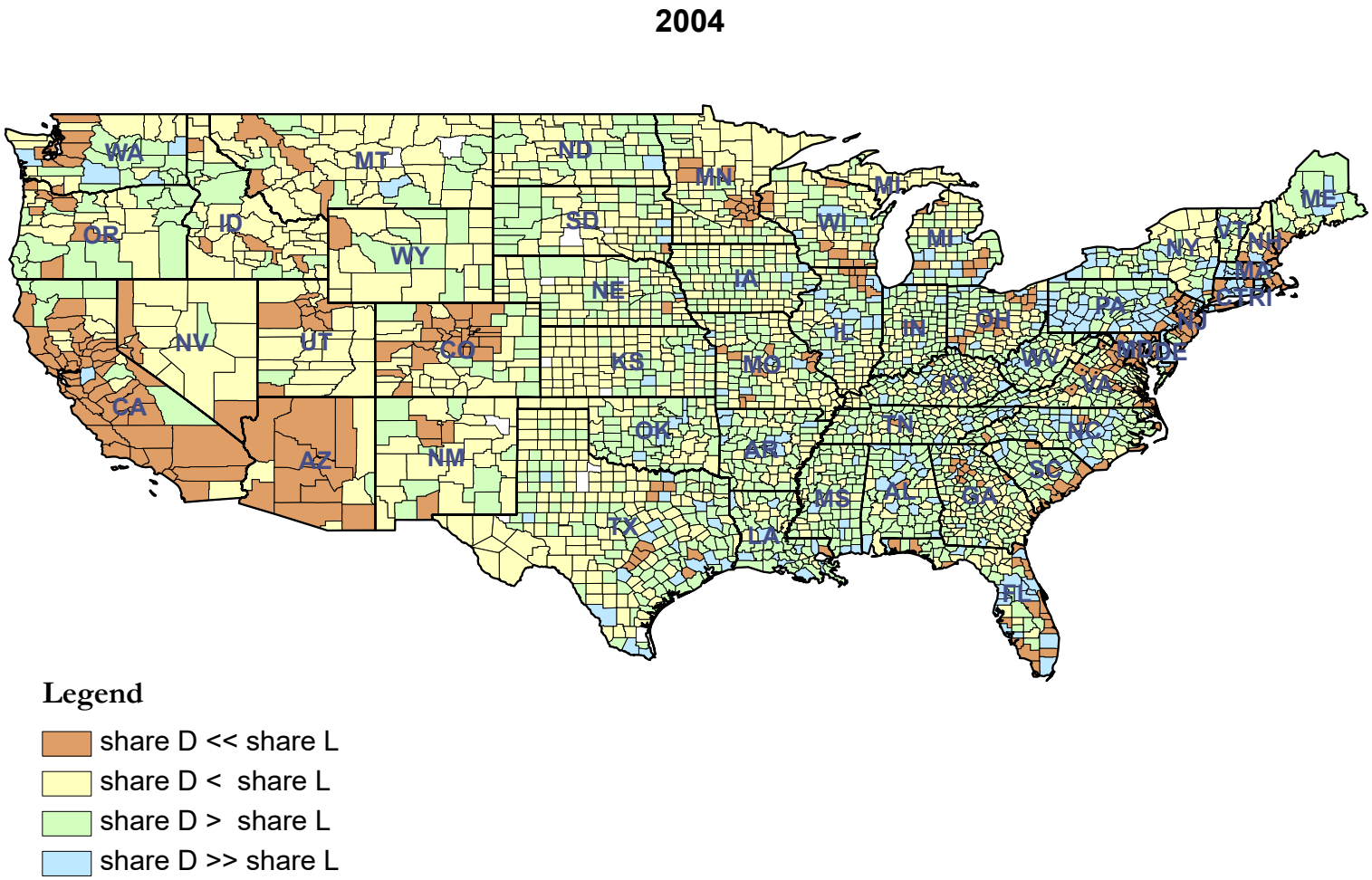
- For each county, we construct S_{L-D} = Share in Loans - Share in Deposits.

- We construct four groups of counties:
  $S_{L-D} < 10$ Pctile [Strong Lender] BLUE
  $S_{L-D} \in [10\% , 50\%]$ [Weak Lender] GREEN
  $S_{L-D} \in (50\% , 90\%]$ [Weak Borrower] YELLOW
  $S_{L-D} > 90$ Pctile [Strong Borrower] BROWN

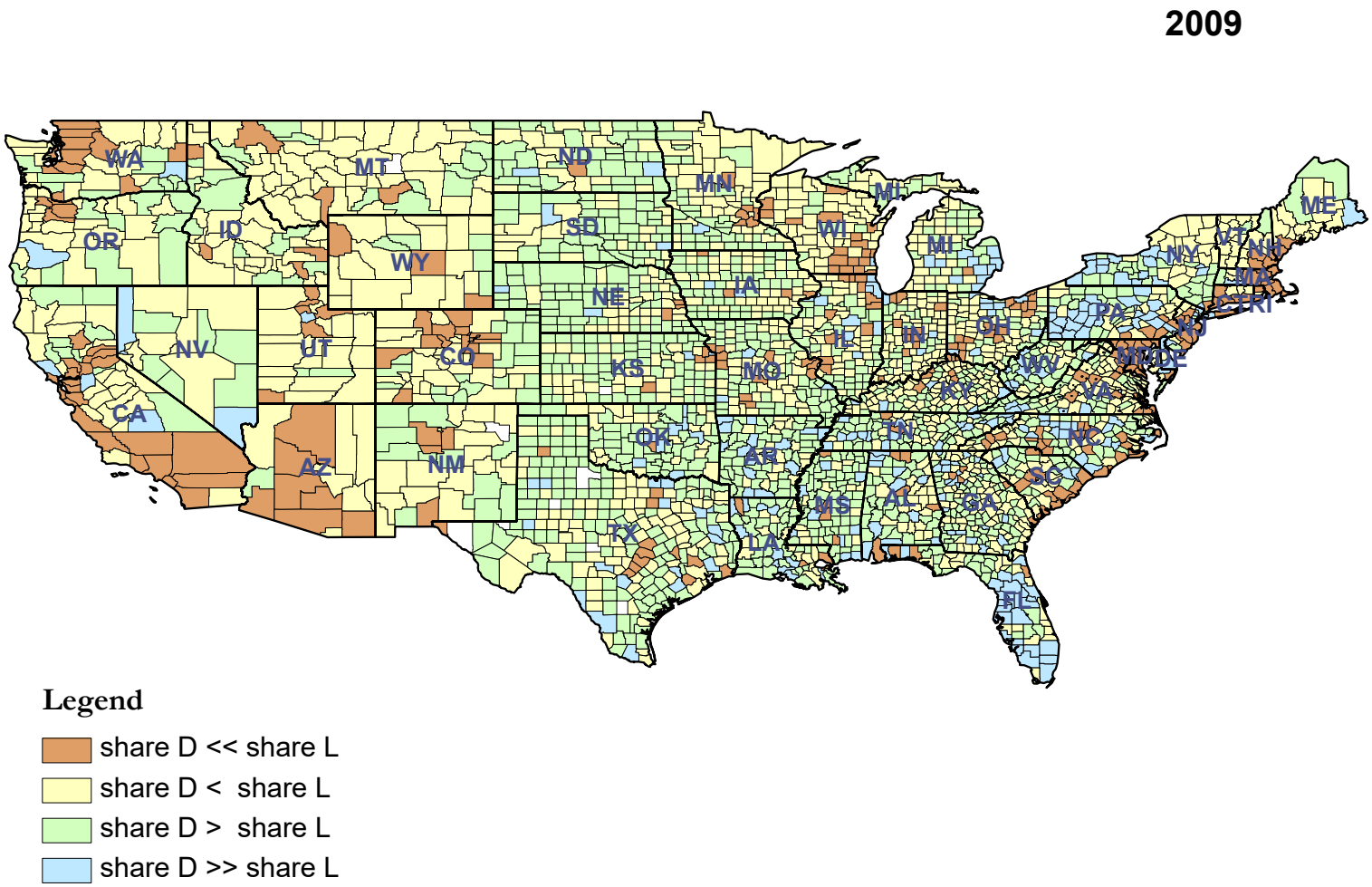
Map of counties Share (L-D): Year 1999



Map of counties Share (L-D): Year 2004



Map of counties Share (L-D): Year 2009



Segregation index

- Bank level: For each bank-year we construct the index:

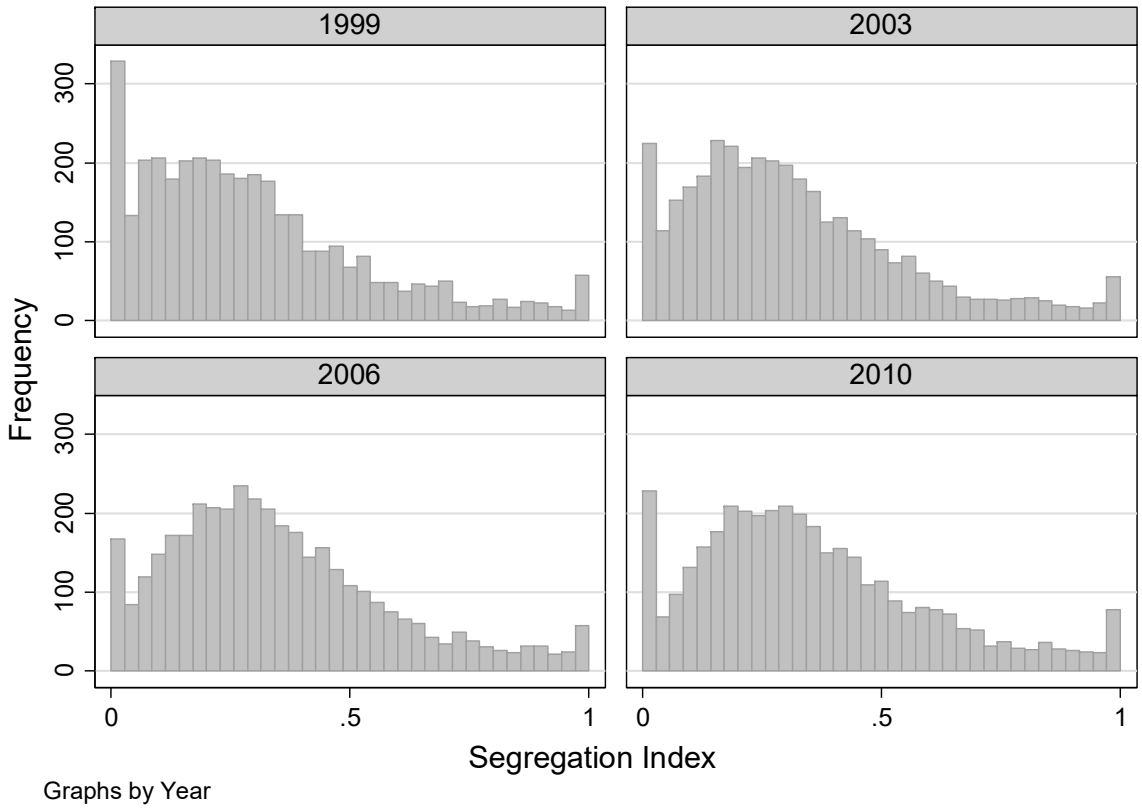
$$SI_{jt} = \frac{1}{2} \sum_{m=1}^{M} \left| \frac{q^d_{jmt}}{Q^d_{jt}} - \frac{q^\ell_{jmt}}{Q^\ell_{jt}} \right|$$

- It tries to measure the fraction of the bank's deposits that is used for loans in a different county.

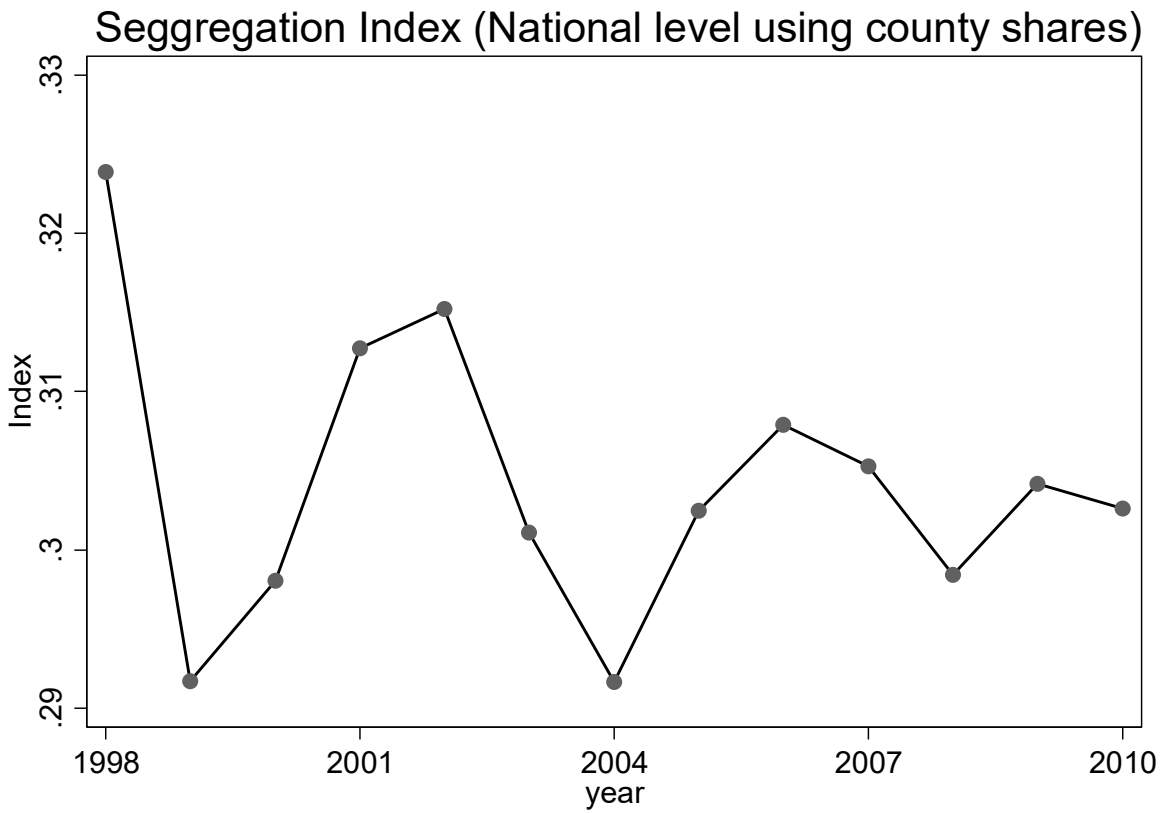
- $SI = 0$: No distribution of deposit funds outside the home counties that generate deposits.

- $SI = 1$: Group of counties that generates deposits is completely segregated from the group of counties that obtains loans.

Distribution of Banks' Segregation indexes



National Segregation index for deposits/loans



Local Market Concentration and "Pass-Through"

Effect of local market power on the allocation of funds across counties

Variable	bank local loans	bank local depo
log bank total deposits ($\ln Q_{jt}^d$)	0.2442^{***}	0.5832^{***}
	(0.0049)	(0.0179)
$[N_{mt}^{\ell} - \overline{N}^{\ell}] \ln Q_{jt}^d$	$\mathbf{0.0023}^{***}$	0.0002
	(0.0003)	(0.0002)
$[N_{mt}^{d} - \overline{N}^{d}] \ln Q_{jt}^d$	-0.0016^{**}	$\mathbf{0.0028}^{***}$
	(0.0004)	(0.0003)

3. Model

Model: Main Features

- **Multiple geographic markets** (counties): each market with its demands of deposits and loans.
- A bank has a set of counties where it sells deposits, and a set of counties where it sells loans. These networks are exogenous in this model.
- Demand and costs of deposit and loans in the same county are **connected** through **economies of scope**.
- Markets of loans and markets of deposits at different counties are **connected** because a bank's total deposits affects its demand and costs for loans and deposits at every county.

A bank variable profit function

- J banks, indexed by j. M geographic markets, indexed by m.
- $\mathcal{M}_j^\ell$ and $\mathcal{M}_j^d$: sets of markets where bank j has loans and deposits (networks).
- The variable profit of bank j is:

$$\Pi_j = \sum_{m=1}^{M} \left[p_{jm}^\ell \; q_{jm}^\ell - p_{jm}^d \; q_{jm}^d - C_{jm}\left(q_{jm}^\ell, \; q_{jm}^d\right) \right] - (r_0 + c_{j0}) \, B_j$$

- p_{jm}^ℓ and p_{jm}^d : interest rates of new loans and deposits.
- q_{jm}^ℓ and q_{jm}^d : amounts of new loans and stock of deposits.
- C_{jm} cost of loans and deposits.
- B_j : bank's net borrowing position at interbank market.

Demand for deposit and loan products

- Amount of deposits of bank j in market m:

$$s_{jm}^d \equiv \frac{q_{jm}^d}{H_m^d} = \frac{1\left\{m \in \mathcal{M}_j^d\right\} \ \exp\left\{\mathbf{x}_{jm}^d \ \beta_m^d + \alpha^d \ p_{jm}^d + \xi_{jm}^d\right\}}{1 + \sum_{k=1}^{J} 1\left\{m \in \mathcal{M}_k^d\right\} \ \exp\left\{\mathbf{x}_{km}^d \ \beta_m^d + \alpha^d \ p_{km}^d + \xi_{km}^d\right\}}$$

- Amount of loans of bank j in market m:

$$s_{jm}^\ell \equiv \frac{q_{jm}^\ell}{H_m^\ell} = \frac{1\left\{m \in \mathcal{M}_j^\ell\right\} \ \exp\left\{\mathbf{x}_{jm}^\ell \ \beta_m^\ell - \alpha^\ell \ p_{jm}^\ell + \xi_{jm}^\ell\right\}}{1 + \sum_{k=1}^{J} 1\left\{m \in \mathcal{M}_k^L\right\} \ \exp\left\{\mathbf{x}_{km}^\ell \ \beta_m^\ell - \alpha^\ell \ p_{km}^\ell + \xi_{km}^\ell\right\}}$$

Consumers' valuation loan products

- Observable component of valuation of a loan product:

$$\mathbf{x}_{jm}^{\ell}\beta_{m}^{\ell} = \mathbf{z}_{m}'\beta_{0}^{\ell} + \beta_{n}^{\ell}(n_{jm}) + \beta_{d}^{\ell}\ s_{jm}^{d} + \beta_{D}^{\ell}\ \ln Q_{j}^{d}$$

- $\beta_{n}^{\ell}(n_{jm})$: number of branches increases demand for loans (consumer transportation costs, awareness).
- $\beta_{d}^{\ell}\ s_{jm}^{d}$: economies of scope between deposits and loans at the consumer level (one-stop banking)
- $\beta_{Q}^{\ell}\ \ln Q_{j}^{d}$: bank's total deposits increases demand for its loan products (default & renewal risks)

Consumers' valuation deposit products

- Observable component of valuation for a deposit product:

$$\mathbf{x}_{jm}^{d}\beta_{m}^{d} = \mathbf{z}_{m}'\beta_{0}^{d} + \beta_{n}^{d}(n_{jm}) + \beta_{\ell}^{d}\ s_{jm}^{\ell} + \beta_{D}^{d}\ \ln Q_{j}^{d}$$

- $\beta_{n}^{d}(n_{jm})$: number of branches increases demand for deposits (consumer transportation costs, awareness).
- $\beta_{\ell}^{d}\ s_{jm}^{\ell}$: economies of scope between deposits and loans at the consumer level (one-stop banking)
- $\beta_{Q}^{d}\ \ln Q_{j}^{d}$: the bank's total deposits increases demand for its deposit products (liquidity risks, default risks)

Demand system for deposit and loans

- Demand system:

$$q_{jm}^{d} = d_{jm}\left(p_{jm}^{d}, s_{jm}^{\ell}, Q_{j}^{d}\right)$$

$$q_{jm}^{\ell} = \ell_{jm}\left(p_{jm}^{\ell}, s_{jm}^{d}, Q_{j}^{d}\right)$$

- This demand system implies "reduced form" demand equations where loans (deposits) in a local market depend on the bank's interest rates for loans and deposits in every market where the bank operates.

$$q_{jm}^{d} = f_{jm}^{d}\left(\mathbf{p}_{j}^{d}, \mathbf{p}_{j}^{\ell}\right)$$

$$q_{jm}^{\ell} = f_{jm}^{\ell}\left(\mathbf{p}_{j}^{d}, \mathbf{p}_{j}^{\ell}\right)$$

Variable cost of deposits and loans

$$
\begin{aligned}
C_{jm}\left(q^{\ell}_{jm}, q^{d}_{jm}\right) &= \left[\omega^{d}_{jm} + \gamma^{d}_{n}\ n_{jm} + \gamma^{d}_{d}\ s^{\ell}_{jm} + \gamma^{d}_{Q}\ \ln Q^{d}_{j}\right]\ q^{d}_{jm} \\
&+ \left[\omega^{\ell}_{jm} + \gamma^{\ell}_{n}\ n_{jm} + \gamma^{\ell}_{d}\ s^{d}_{jm} + \gamma^{\ell}_{Q}\ \ln Q^{d}_{j}\right]\ q^{\ell}_{jm}
\end{aligned}
$$

Nash-Bertrand equilibrium

- Each bank chooses its vector of interest rates of deposits and loans at every market where active to maximize its profit.
- F.O.C. for p^d_{jm} is:

$$\underbrace{\left[q^d_{jm} + \left(p^d_{jm} - \frac{\partial C_{jm}}{\partial q^d_{jm}}\right)\frac{\partial f^d_{jm}}{\partial p^d_{jm}}\right]}_{\text{effect local Deposits}} + \underbrace{\left(p^\ell_{jm} - \frac{\partial C_{jm}}{\partial q^\ell_{jm}}\right)\frac{\partial f^\ell_{jm}}{\partial p^d_{jm}}}_{\text{effect local Loans}}$$

$$+ \underbrace{\sum_{m' \neq m}\left(p^d_{jm'} - \frac{\partial C_{jm'}}{\partial q^d_{jm'}}\right)\frac{\partial f^d_{jm'}}{\partial p^d_{jm}}}_{\text{effect other counties Dep.}} + \underbrace{\sum_{m' \neq m}\left(p^\ell_{jm'} - \frac{\partial C_{jm'}}{\partial q^\ell_{jm'}}\right)\frac{\partial f^\ell_{jm'}}{\partial p^d_{jm}}}_{\text{effect other counties Loans}} = 0$$

Equilibrium Equations: Fixed-Point in Market Shares

- Under the logit specification of demand, the system of marginal conditions of optimality imply the following pricing equations:

$$p_{jm}^{\ell} = c_{jm}^{\ell} + \Delta_j^{\ell} + \frac{1}{\alpha^{\ell}(1 - s_{jm}^{\ell})} - \frac{\beta_{\ell}^{d}}{\alpha^{d}} s_{jm}^{d}$$

- Δ_j^{ℓ} is endogenous and it depends on marginal conditions at all the loan markets where bank j operates.

- From the logit demand models, we also have:

$$\ln(s_{jm}^{\ell} / s_{0m}^{\ell}) = \mathbf{x}_{jm}^{\ell} \beta_m^{\ell} + \alpha^{\ell} p_{jm}^{\ell} + \xi_{jm}^{\ell}$$

Fixed-Point in Market Shares

- Solving the pricing equations into the demand equations, we get:

$$\begin{cases} y^{\ell}_{jmt} &= \mathbf{x}^{\ell}_{jm}\ \theta^{\ell} + \Delta^{\ell}_{j} + \eta^{\ell}_{jmt} \\ y^{d}_{jmt} &= \mathbf{x}^{d}_{jm}\ \theta^{d} + \Delta^{d}_{j} + \eta^{d}_{jmt} \end{cases}$$

with $y^{d}_{jmt} \equiv \ln\left(\frac{s^{d}_{jm}}{s^{d}_{0m}}\right) + \frac{1}{1-s^{d}_{jm}}$ and $y^{\ell}_{jmt} \equiv \ln\left(\frac{s^{\ell}_{jm}}{s^{\ell}_{0m}}\right) + \frac{1}{1-s^{\ell}_{jm}}$.

- And the parameters θ^{ℓ} and θ^{d} are known functions of structural parameters of both demand and costs. that depend on both demand:

$$\theta^{d} \equiv \beta^{d} - \alpha^{d}\gamma^{d}, \qquad \text{and} \qquad \theta^{\ell} \equiv \beta^{\ell} - \alpha^{\ell}\gamma^{\ell}$$

4. Estimation

Estimation of Structural Model

- The equilibrium equations have the following form:

$$y^d_{jmt} = \mathbf{z}'_{mt}\delta^d + \theta^d_n(n_{jmt}) + \theta^d_\ell \; s^\ell_{jmt} + \theta^d_Q \; \ln(Q^d_{jt}) + \eta^d_{jmt}$$

$$y^\ell_{jmt} = \mathbf{z}'_{mt}\delta^\ell + \theta^\ell_n(n_{jmt}) + \theta^\ell_d \; s^d_{jmt} + \theta^\ell_Q \; \ln(Q^d_{jt}) + \eta^\ell_{jmt}$$

- Simultaneity: The model implies that s^ℓ_{jmt}, s^d_{jmt}, and $\ln(Q^d_{jt})$ are correlated with the unobservables.

- Endogeneity: Number of branches, n_{jmt}, is exogenous in model, but we expect it is correlated with unobservables.

Identification Assumptions

- Our identification approach is based on several assumptions on the unobservables:

- [1] A Fixed-Effects Structure:

$$\eta_{jmt}^{d} = \eta_{jm}^{d(1)} + \eta_{t}^{d(2)} + \eta_{mt}^{d(3)} + \eta_{jt}^{d(4)} + \eta_{jmt}^{d(5)}$$

- [2] Restrictions on the serial correlation of the remaining transitory shocks (such that we can used lagged exogenous and endogenous variables as instruments).

- [3] After controlling for county-year effects, the bank-year effects are not correlated with exogenous socioeconomics at counties where the bank operates.

$$\mathbb{E}\left(\mathbf{z}_{mt}\ \eta_{jt}^{d(4)}\right) = \mathbb{E}\left(\mathbf{z}_{mt}\ \eta_{jt}^{\ell(4)}\right) = 0$$

Identification: Moment conditions

- **DiDiD:** difference between two banks in the same county, time-difference, & difference between two counties in the bank's network.
- In this DiDiD equation, own branches and branches of competitors, both at t-2 and before, are valid instruments. [Arellano-Bond instruments]
- **DiD:** difference between two banks in the same county & time-difference.
- In this DiD equation, we can use Z's in other counties to instrument the bank's total deposits.

Estimation Results: Branch effects

Equilibrium equations for Deposits and Loans		
Variable	Deposits	Loans
First branch ($1\{n_{jmt} \geq 1\}$)	-	3.1972^{***} (0.0848)
Second branch ($1\{n_{jmt} \geq 2\}$)	0.8538^{***} (0.0137)	0.2380^{***} (0.0178)
Third branch ($1\{n_{jmt} \geq 3\}$)	0.4588^{***} (0.0136)	0.1839^{***} (0.0203)
Fourth branch ($1\{n_{jmt} \geq 4\}$)	0.3683^{***} (0.0149)	0.1672^{***} (0.0243)
Fifth branch ($1\{n_{jmt} \geq 5\}$)	0.5180^{***} (0.0161)	-0.0931^{*} (0.0449)
more than 5 branches	0.0758^{***} (0.0016)	0.0281^{***} (0.0015)

Estimation Results: Local and global effects

Economies of scope and total deposits		
Variable	Deposits	Loans
log own loans in county	0.0626^{***}	-
	(0.0023)	
log own deposits in county	-	0.3721^{***}
		(0.0079)
log total own deposits	0.0987^{***}	0.1839^{***}
	(0.0042)	(0.0014)

Counterfactual Experiments

- **Experiment 1.** No multi-state branch networks.
- **Experiment 2.** Eliminate home-bias due to econ scope deposits & loans: $\theta_d^\ell = \theta_\ell^d = 0$.
- **Experiment 3.** Fix the same number of banks at every county:
- **Experiment 4.** 20% tax on deposits.
- **Experiment 5.** Eliminate aggregate shocks.

Counterfactual Experiments

Counterfactual Experiments

Outcome Variable	Data	Exp. 1 No m.s.n.	Exp. 2 No ec.s.	Exp. 3 No h.m.p.	Exp. 4 Tax depo	Exp. 5 No agg.
Segregation index	0.32	0.26	0.30	0.48	0.29	0.30
Bottom 2500	9%	11%	9%	12%	9%	8%
Top 100	58%	50%	55%	49%	55%	59%

Conclusions

- We study empirically to what extent branch networks facilitate the geographic flow of bank funds, and the role of economies of scope and local market power as impediments to the flow of credit.
- Our results are based on the estimation of a structural model of bank oligopoly competition for deposits and loans in multiple geographic markets, using a dataset that merges deposit and mortgage-loan data.
- Branch networks geographic expansion has increased the geographic diffusion of credit but has benefited top-credit counties and a negative effect on bottom credit counties.
- Local market power has a substantial negative impact on the diffusion of credit, and particularly negative for small-low credit markets.