Diversification of Geographic Risk in Retail Networks: Evidence from Bank Expansion after Riegle-Neal

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Motivation: Retail Networks and Geographic Risk

- Role of **Geographic Risk Diversification** (GRD) in growth and spatial configuration of **Retail Chains**.
- **Retail Chain:** Collection of stores at different geographic markets.
- **Geographic Risk:** Revenues and costs in a geographic market depend on idiosyncratic risk.
- **Diversification:** By opening branches in multiple local markets a retail chain can reduce the risk in its profits.
- Other factors (e.g., **diseconomies of scale** in the number of stores, **economies of density**, adjustment costs) can counterbalance GRD.

Our Application

- We study the **US retail banking industry** during **1994-2006**, before and after policy change (the **Riegle-Neal Act**) that eliminated very strong restrictions to geographic expansion of retail banks.
- Ideal setting to study GRD of retail networks.
- **Main empirical questions**:

(a) *Does bank expansion after Riegle-Neal reveal banks concern for diversification of* **liquidity risk***?*

(b) *What were the effects of this deregulation on banks competition for liquidity, and on liquidity risk?*

Outline

[1] Riegle-Neal Act

[2] Data

[3] Measuring Geographic Risk: A Factor Model

[4] Evolution of Banks' Geographic Risk

[5] Model of Bank Branch Networks

[6] Summary of Results and Conclusions

1. Riegle-Neal Act

US Baking Industry before Riegle-Neal

- US has a long tradition against a nationwide banking system.
- Until 1994, the **McFadden Act (1927)** and the **Banking Act (1933)** prohibited branching across state lines.
- Prior to the 1970s many states had laws restricting **within state branching**. Until 1990, there are still 7 states with "unit-branch-banks".

US Baking Industry in 1994

Descriptive Statistics	Year 1994
Number of banks	12,976
Number of branches	80,795
Average number of branches per bank	6.2
Median number of branches per bank	2
% Banks with only 1 branch	42%
% Banks with branches in only 1 county	76%

Deregulation: Riegle-Neal Act (1994)

- During the 1970s and 1980s, there was a move towards the elimination of restrictions on geographic expansion for banks.

- The most important change came with the Riegle Neal Act in 1994, that **permitted interstate branching**:

  \- **by merger/acquisition:** *Automatic as of June 1st 1997.*

  \- **by denovo branching:** *Not automatic. States have to opt-in, at any time. In 2011, still 19 states do not allow for inter-state denovo branching.*

Original Motivation of the Riegle-Neal Act

- It was believed that removing restrictions on geographic expansion would improve banks risk diversification.

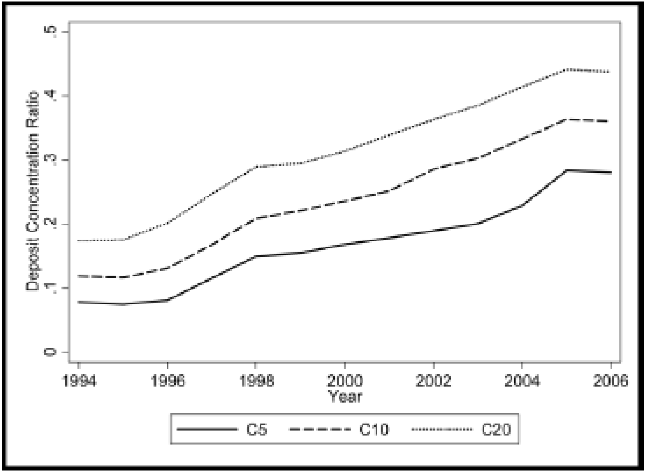
- **Economic Report of the President: Year 1991.**

  "Interstate branching restrictions prevent banks and thrifts from diversifying efficiently. They are obstacles to the efficiency, profitability, safety, and soundness of the financial sector. The Administration will propose legislation to allow interstate banking and branching."

- **Laurence Meyer, Member Federal Reserve Board (1996).**

  "The Riegle-Neal Act of 1994 overturns the McFadden Act prohibition on interstate branching. The removal of these artificial barriers to trade will likely improve efficiency and diversification of risks in the banking industry."

Figure 2: Industry Concentration Ratios (Deposits)



US Baking Industry in 2006

Descriptive Statistics	Year 1994	Year 2006
Number of banks	12,976	8,749
Number of branches	80,795	94,123
Average number of branches per bank	6.2	10.8
Median number of branches per bank	2	3
% Banks with only 1 branch	42%	29%
% Banks with branches in only 1 county	76%	41%

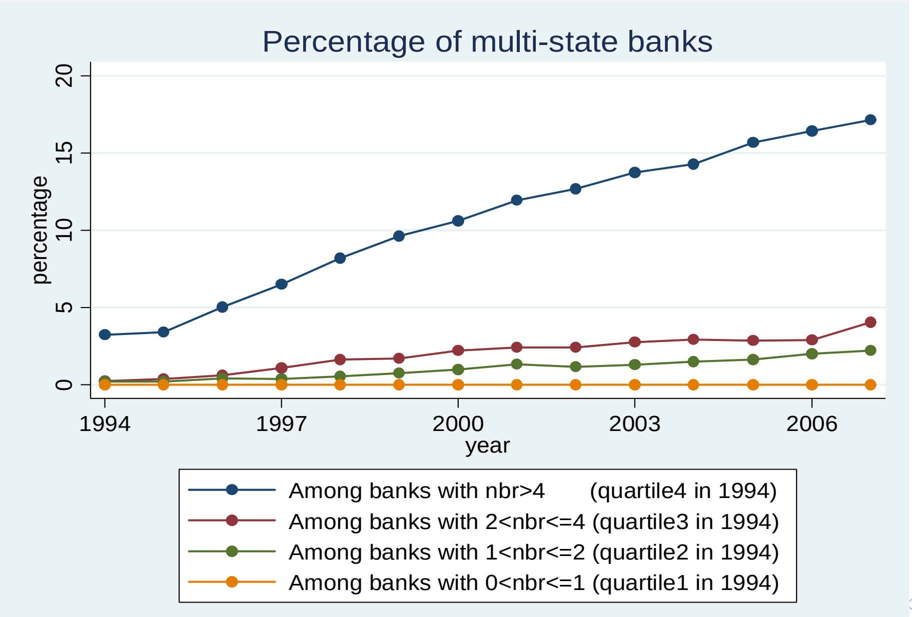
2. Data

Data Sources

- Branch and deposits information from the *Summary of Deposit* data provided by the *Federal Deposit Insurance Corporation* (FDIC).
- County socioeconomic characteristics come from various data products of the Census Bureau. (Demographic, income, and coordinates at the county level.)
- M&A information from the National Information Center.
- Riegle-Neal Act information from different sources (Chicago Fed).
- Period 1994-2006. More than 12,000 banks; 3,100 counties in the 50 states and the District of Columbia.

TABLE 1. Descriptive Statistics

Statistics	1994	1997	Year 2000	2003	2006
Banks:					
Number of banks	12,976	11,164	10,098	9,238	8,749
Change in # banks during last 3 years		-1812	-1066	-860	-489
Openings of banks during last 3 years		402	735	391	477
Closing banks last 3 years due to mergers		2154	1761	1187	937
Closing banks last 3 years due to failures		60	40	64	29
Branches:					
Number of branches	80,795	81,553	84,909	87,183	94,123
Average number of branches per bank	6.2	7.3	8.4	9.4	10.8
Median number of branches per bank	2	2	2	3	3
% denovo from banks with HQs in other state	8.9	15.8	21.6	30.9	32.7
Branch creation from mergers (%)					
Overall sample	64.8	68.7	57.5	51.0	53.5
In markets within the same state as bank HQs	60.9	49.7	43.1	33.3	32.8
In markets in different state than bank HQs	82.7	91.0	75.7	65.2	67.9


Percentage of multi-state banks
percentage
20
15
10
5
0
1994
1997
2000
2003
2006
year
Among banks with nbr>4 (quartile4 in 1994)
Among banks with 2<nbr<=4 (quartile3 in 1994)
Among banks with 1<nbr<=2 (quartile2 in 1994)
Among banks with 0<nbr<=1 (quartile1 in 1994)

3. Measuring Geographic Risk: Factor Model

Factor Model

- Regression model for log-deposits-per-branch:

$$\ln\left(d_{mt}\right) = \alpha_m(\mathbf{X}_t) + \beta_m(\mathbf{X}_t)\ \mathbf{f}_t + u_{mt},$$

- $\mathbf{X}_t$ represents a vector of variables with all the information available to banks at period t,
- $\alpha_m(.)$ is a deterministic function of $\mathbf{X}_t$,
- $\beta_m(.)$ is a $1 \times F$ vector of deterministic functions of $\mathbf{X}_t$
- $\mathbf{f}_t$ is an $F \times 1$ vector of random variables or *factors* that are common to all the markets.
- u_{mt} is a random variable that is market specific.

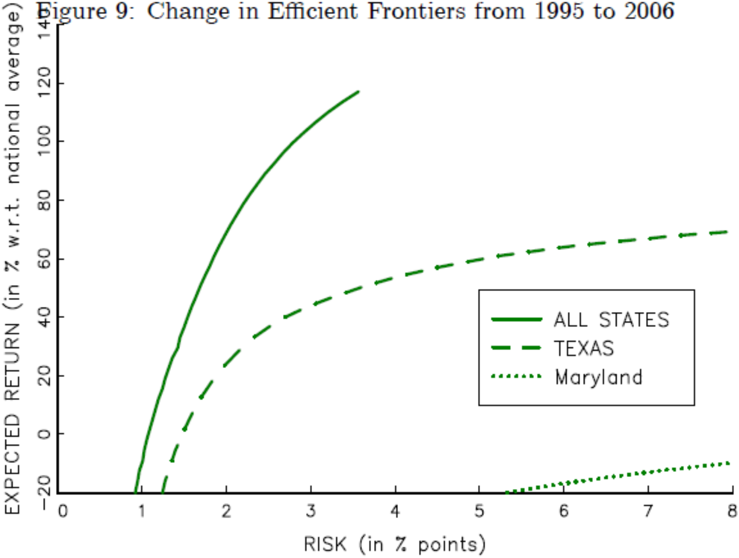
Main Results form Factor Model

- The estimated level of liquidity risk is quite substantial.
- **Systematic risk** is between 0.6 and 2.3 percentage points;
- **Diversifiable risk** is between 1.1 and 3.1 percentage points (This is the level of risk that a bank would have if it operates only in one county).
- Very substantial cross-state heterogeneity in the possibilities for GRD before RN, both for large banks and for small banks.

Feasible Minimum Risk for Small Banks
before Riegle-Neal. Year 1995

State (# counties)	Minimum Risk with n branches (%)			
	n = 1	n = 5	n = 10	MinRisk
Texas (248)	2.39	0.74	0.57	0.40
Missouri (115)	2.23	0.69	0.56	0.45
Georgia (156)	2.64	0.75	0.58	0.47
N. Carolina (100)	2.15	0.69	0.55	0.47
...	...	...	...	...
Massachusetts (14)	2.48	1.43	1.39	1.37
Nevada (16)	3.25	1.55	1.41	1.34
Rhode Island (5)	2.17	1.65	1.66	1.65
Hawaii (4)	3.67	3.17	3.15	3.12

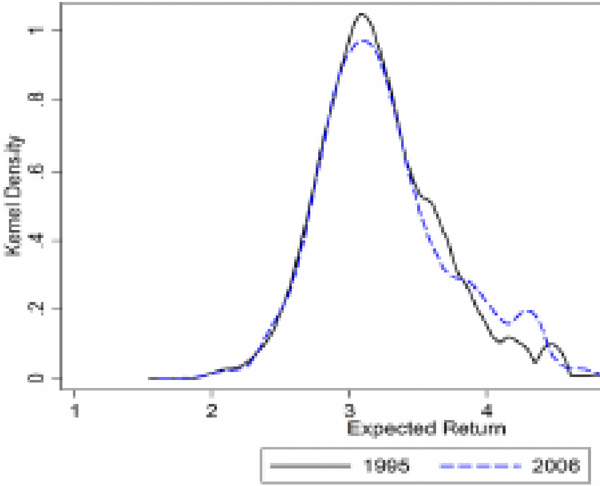
Figure 9: Change in Efficient Frontiers from 1995 to 2006



4. Evolution of Banks' Liquidity Risk

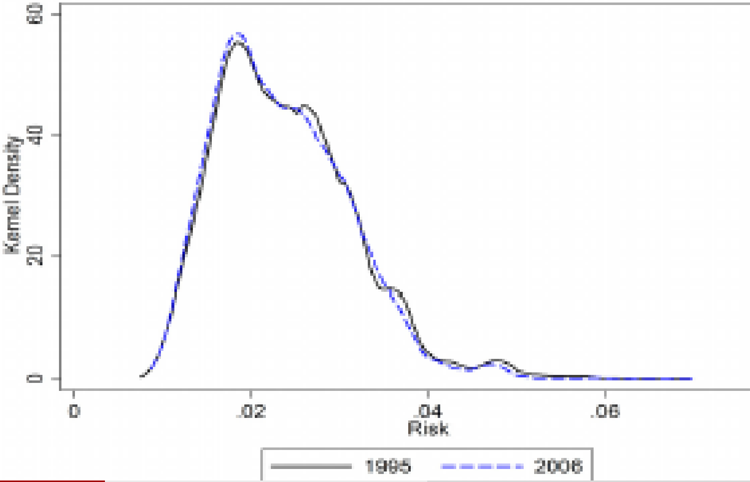
Some improvement in expected LDPB (i.e., the median value goes from 3.17 to 3.19, an improvement of 2 percentage points)

Figure 11A: Distribution of banks' expected log-depos



... but almost no reduction in risk (i.e., the median value goes from 0.0230 to 0.0226, a reduction in 0.04 percentage points).

Figure 11B: Distributions of banks' risk of deposits: 19



Decomposition of Evolution of Bank Risk

- Almost all the reduction in GR comes from **within state mergers.**
- If we consider distributions wighted by the volume of deposits of banks, we find that:
- (a) within state expansion has contributed to reduce GR;
- (b) out of state expansion has *increased* both risk and the level of LDPBs for large banks.

Figure 12: Decomposition of change in distribution of banks' risk: 1995-2006

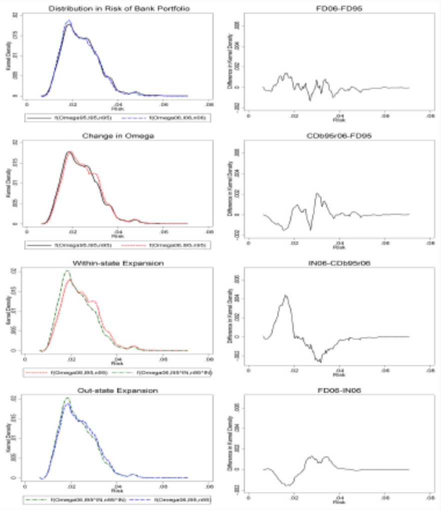
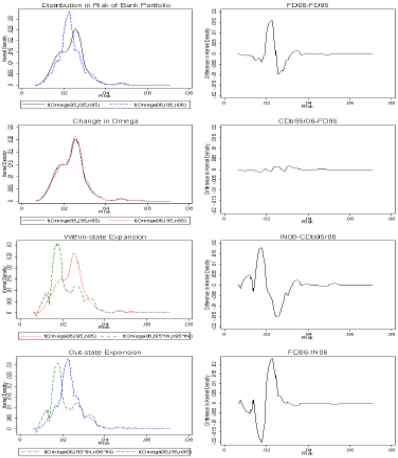


Figure 14: Decomposition of change in distribution of banks' risk: 1995-2006

Each bank observation is weighted by the bank total volume of deposits



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5. Model

Main purpose of structural model

- RN expanded banks' possibilities of GRD but most banks did not take advantage of these possibilities.
- One explanation for this finding is that banks are not seriously concerned about GRD.
- An alternative explanation is that other factors, such as diseconomies of scale, economies of density, merging costs, and local market power have counterbalanced banks' concern for GRD.
- We propose and estimate a structural model of competition between branch networks where banks are (potentially) concerned with geographic risk.

Model of bank competition

- The model has **two levels of competition** between retail banks.

  - **Local competition:** *Branches in the same local market (county).compete for deposits.*

  - **National competition between bank networks:** *Banks choose the number of branches at each geographic local market.*

- Liquidity from deposits can be transferred between branches of the same bank at a very low cost.
- Banks can obtain additional liquidity in the interbank money market but this is costly. This cost generates a bank's concern for liquidity risk.

Local Market Competition

- Number of branches of each bank in a local market is determined in the game of network competitionand it is exogenous in this game of local market competition.

- Branches compete for the supply of deposits from households and businesses in the market.

- The Nash equilibrium in this model of local competition implies equilibrium functions that relate the deposits and the profits of a bank in a local market with the number of branches, their ownership structure, and exogenous market characteristics:

$$D_{imt} = f_d(n_{imt}, \mathbf{n}_{mt}, X_{mt})$$

$$\pi_{imt} = f_\pi(n_{imt}, \mathbf{n}_{mt}, X_{mt})$$

- For the purpose of this paper, we are interested in the equilibrium functions f_d and f_π more than in the structural estimation of demand

Local Market Competition (2)

- Cournot model with multiple branches, linear consumer supply of deposits, and a convex cost function that is consistent with the descriptive evidence.

- Consumer supply of deposits in market m at period t is described by the equation: $r_{mt} = \alpha_{mt} + \beta \; D_{mt}$.

- Variable profit of this bank is:

$$\pi_{imt} \quad = \quad \left(p_{mt} - r_{mt}\right) \; D_{imt} - C_{mt}\left(D_{imt}, n_{imt}\right).$$

- p_{mt} represents the return from the best lending options in this market, and we assume that it is exogenously given.

- $C_{mt}\left(D, n\right)$ represents the variable cost of the bank for managing a volume of deposits D using n branches. We consider the following specification of this cost function:

$$C_{mt}\left(D, n\right) \equiv \gamma_{mt} \; D + \left[\delta(n)/2\right] \; D^2$$

Local Market Competition (3)

- Equilibrium amount of deposits of a bank:

$$D^*_{imt} = \left(\frac{p_{mt} - \alpha_{mt} - \gamma_{mt}}{\beta (I^*_{mt} + 1)} \right) \left(\frac{1}{1 + \frac{\delta(n_{imt})}{\beta}} \right),$$

where $I^*_{mt} \equiv \sum_{j=1}^{I_t} \frac{1}{1+\delta(n_{jmt})/\beta}$ can be interpreted as the "effective" number of banks in the local market.

- The equilibrium value of variable profits is:

$$\pi^*_{imt} = \beta \left[1 + \frac{\delta(n_{imt})}{2\beta} \right] (D^*_{imt})^2.$$

Number of Branches and Deposits for a Bank in a County

Dependent variable: $\ln(D_{imt})$

Parameter	Fixed-Effects		Arellano-Bond	
	Estimate	*(s.e.)*	*Estimate*	*(s.e.)*
$\sigma(2)$	0.2380	(0.0060)	0.2230	(0.0188)
$\sigma(3)$	0.1628	(0.0050)	0.2143	(0.0166)
$\sigma(4)$	0.1389	(0.1886)	0.1563	(0.0155)
...	...		...	
$\sigma(n > 20)$	0.0120	(0.0016)	0.0227	(0.0025)
ln(Deposits[t-1])	0.4035	(0.0071)	0.3475	(0.0078)
ln(County population)	0.4661	(0.0246)	0.4116	(0.0428)
ln(County income-per-capita)	0.1942	(0.0174)	0.1247	(0.0142)
Time dummies (#)	YES (11)		YES (10)	
County $\times$ Bank FEs	YES		YES	
Number of observations	277,408		232,812	

Model: Branch Network

- A bank chooses its branch network $\mathbf{n}_{it}$ to maximize its expected value, $\mathbb{E}(V_{it}|\mathbf{X}_t)$:

$$\mathbb{E}(V_{it}|\mathbf{X}_t) \quad = \quad \sum_{m=1}^{M} \pi^*_{imt} - FC_{it}(\mathbf{n}_{it}) - AC_{it}(\mathbf{n}_{it}, \mathbf{n}_{it-1}) - \rho_{it} \;\; \Pr(D_{it} \leq$$

- **(a) Variable profit.** $\sum_{m=1}^{M} \pi^*_{imt}$, is the sum of variable profits from all the local markets where the bank is active.
- **(b) Fixed operating costs.** $FC_{it}(\mathbf{n}_{it})$ captures economies of scale and density in the operation of a branch network.
θ_1^{FC} [#branches] $+\theta_2^{FC}$ [#branches]^2 + θ_3^{FC} [#branches * distance-to-HQs] $+\theta_4^{FC}$ [#branches * (distance-to-HQs)^2]

Model: Branch Network (2)

- **(c) Adjustment costs.** $AC_{it}(\mathbf{n}_{it}, \mathbf{n}_{it-1})$ includes costs of adjusting or changing the branch network, including merging costs and costs of denovo branching.
  θ_1^{AC} [# new branches via denovo, within HQs state] + θ_2^{AC} [# new branches via denovo, outside HQs state] + θ_3^{AC} [# new branches via merger, within HQs state] + θ_4^{AC} [# new branches via merger, outside HQs state].

- **(d) Cost of liquidity shortage.** $\Pr(D_{it} \leq L_i - E_i \mid \mathbf{X}_t)$ is the probability of liquidity shortage.

$$\Phi\left(\frac{L_i - E_i - \mathbb{E}(D_{it}|\mathbf{X}_t)}{\sqrt{\mathbb{V}(D_{it}|\mathbf{X}_t)}}\right)$$

Model: Branch Network (3)

- Expected value of a bank

$$\mathbb{E}\left(V_{it} \mid \mathbf{X}_t\right) = W_{it}(\mathbf{n}_{it})\boldsymbol{\theta} + \varepsilon_{it}(\mathbf{n}_{it})$$

- $W_{it}(\mathbf{n}_{it})$ is the vector of known functions $\{\Pi_{it}(\mathbf{n}_{it}), -\Phi_{it}\Pi_{it}(\mathbf{n}_{it}),$ [#branches], [#branches]^2, [#branches * distance-to-HQs], [#branches * (distance-to-HQs)^2], [# new branches via denovo, within HQs state], [# new branches via denovo, outside HQs state], [# new branches via merger, within HQs state], [# new branches via merger, outside HQs state]$\}$

- $\boldsymbol{\theta}$ is the vector of parameters $(\beta, \bar{\rho}, \theta_1^{FC}, \theta_2^{FC}, \theta_3^{FC}, \theta_4^{FC}, \theta_1^{AC}, \theta_2^{AC}, \theta_3^{AC}, \theta_4^{AC})'$

- $\varepsilon_{it}(\mathbf{n}_{it})$ represents other factors that are unobservable to the researcher but known to the bank

Model: Branch Network (4)

- We apply the principle of revealed preference to estimate (up to scale) the vector of parameters $\boldsymbol{\theta}$.

$$\mathbf{n}_{it} = \arg\max_{\mathbf{n} \in A_{it}} \left\{ W_{it}(\mathbf{n}) \ \boldsymbol{\theta} + \varepsilon_{it}(\mathbf{n}) \right\},$$

- We estimate the structural parameters of our model using a *Moment Inequalities estimator* (MIE).

$$\mathbb{E}\left(\mathbf{Z}_{it} \ \left[\left(W_{it}(\mathbf{n}_{it}) - W_{it}(\mathbf{n}) \right) \frac{\boldsymbol{\theta}^0}{\sigma_\varepsilon} + K \right] \right) \geq 0,$$

Estimation of Bank Network Costs and Benefits

Parameter	Estimate	(s.e.)[1]
β/σ_ε (in million \$)	3.2135	(0.8720)
Cost of Insolvency Parameter $\overline{\rho}$	8.4380^{**}	(1.5200)
Branch network diseconomies of scale:		
Number of branches (in million \$ per branch)	-1.9802^{**}	(0.6163)
Number of branches square (in million \$ per branch sq.)	-0.0706^{*}	(0.0620)
Number of observations (#banks)	120,812	(14,127)

Estimation of Bank Network Costs and Benefits

Parameter	Estimate	(s.e.)(1)
Branch network economies of density:		
Average distance to county HQs	-0.1435**	(0.0387)
(in million $ per 100 miles and per branch)		
Average distance to county HQs square	0.0050	(0.0063)
Branch network adjustment costs. Denovo branching		
Denovo Branch Creation within state (in million $ per branch)	-1.3325**	(0.2803)
Denovo Branch Creation out state (in million $ per branch)	-2.1597**	(0.4239)
Branch network adjustment costs. Merger		
Merger within state (in million $ per new branch)	-0.6480**	(0.3985)
Merger out state (in million $ per new branch)	-1.1871**	(0.4200)
Merger within state × small bank (in million $ per new branch)	-1.4410*	(0.9106)
Merger out state × small bank (in million $ per new branch)	-2.4309**	(0.6767)

Estimation Results

- $\bar{\rho}$: statistically and economically significant. Each percentage point of probability of liquidity shortage is equivalent to an ad valorem tax on deposits of 8.4%.

- Fixed costs: significant diseconomies of scale. Fixed cost of the first branch is \$1.98 millions, and the cost per branch increases with the number of branches;

- Fixed costs: economies of density. The operating cost increases with the average distance of the branch network to the county with bank's headquarters. Every 100 miles of average distance to the headquarters implies an increase in the cost-per-branch of $\$143,000$.

Estimation Results

- Costs of denovo branching and merging are sizeable. There are significant differences in these costs if the expansion is within the same state or to another state.
- The estimated merging cost per acquired branch is smaller than the cost of denovo branching especially for out of state expansions.

Counterfactual experiments

- **Experiment 1:** Shut down the effect of GRD by making the parameter $\bar{\rho}$ equal to zero.
- **Experiment 2:** We eliminate economies of density by fixing θ_3^{FC} and θ_4^{FC} to zero.
- We focus on the following predictions: (a) average annual probability of adding new branches (through denovo or merger) outside the home county; (b) average annual probability of adding new branches outside of the home state; and (c) average annual change in geographic deposit risk. We distinguish between small banks (i.e., three branches or less), medium (4 to 20 branches), and large banks (21 or more branches).

Counterfactual experiments: Results

- **Experiment 1:** Eliminating banks' concern for risk has a very important impact on the network expansion of small banks, but a negligible effect on medium and large banks.
- For small banks, the probability of increasing the number of branches within the home state goes from 5.2% to 1.8%, and the probability of expanding out of the home state becomes practically zero.
- **Experiment 2:** Shutting down economies of density has a very important effect on the network expansion of all the banks, though the stronger effect is for banks of medium size.

Counterfactual Experiments using Model of Branch Networks				
Statistic	Actual Value	Model Prediction	Exp. 1 $\bar{\rho} = 0$	Exp. 2 $\theta_3^{FC} = \theta_4^{FC} =$
Small banks (#branches$\leq$ 3)				
Prob. new br. outside home county (%)	4.97	5.20	1.83	6.47
Prob. new br. outside home state (%)	0.36	0.43	0.02	0.75
Annual change risk (pctage points)	-0.062	-0.071	-0.032	-0.082

Counterfactual Experiments using Model of Branch Networks				
Statistic	Actual Value	Model Prediction	Exp. 1 $\bar{\rho} = 0$	Exp. 2 $\theta_3^{FC} = \theta_4^{FC} =$
Medium banks ($4 \leq$#branches≤ 20)				
Prob. new br. outside home county (%)	16.93	14.66	13.68	16.50
Prob. new br. outside home state (%)	1.92	1.64	1.63	4.71
Annual change risk (pctage points)	-0.034	-0.028	-0.026	-0.045

Counterfactual Experiments using Model of Branch Networks				
Statistic	Actual Value	Model Prediction	Exp. 1 $\bar{\rho} = 0$	Exp. 2 $\theta_3^{FC} = \theta_4^{FC} =$
Large banks (#branches$\geq$ 21)				
Prob. new br. outside home county (%)	43.77	38.18	37.98	45.39
Prob. new br. outside home state (%)	17.34	15.83	15.80	18.79
Annual change risk (pctage points)	-0.002	0.000	0.000	-0.001

Main Empirical Findings

1. There is significant location-specific geographic risk.
2. Before RN, there was large between-state heterogeneity in the possibilities of GRD.
3. RN has expanded significantly the possibilities of GRD of banks with HQs in small/homogeneous states.
4. However, very few banks have taken advantage of RN to reduced geographic risk. Out-of-state branch expansion accounts for a very small fraction of the change in the distribution of banks' risks.

Main Empirical Findings (II)

5. There has been a significant reduction in banks geographic risk during 1995-2006. However, most of this reduction can be explained by: (a) an exogenous decline in risk associated to growth of relatively small markets; and (b) within-state branch expansion.

6. Our estimates of banks' preferences show a significant banks' concern for GRD.

7. Nevertheless, this concern for GRD has been counter-balanced by four important factors: (1) economies of density; (2) large costs of out-of-state de-novo branching; (3) large costs of mergers, especially for small banks; and (4) in general, banks in small states are not the most attractive partners for a merger because they are small with low rates of return and high risk.