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# Branching Deregulation and Merger Optimality<sup>1</sup>

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## **Abstract**

The U.S. banking industry has been characterized by intense merger activity in the absence of economies of scale and scope. We claim that the loosening of geographic constraints on U.S. banks is responsible for this consolidation process, irrespective of value-maximizing motives. We demonstrate this by putting forward a theoretical model of banking competition and studying banks' strategic responses to geographic deregulation. We show that even in the absence of economies of scale and scope, bank mergers represent an optimal response. Also, we show that the consolidation process is characterized by merger waves and that some equilibrium mergers are not profitable per se -they yield losses- but become profitable as the waves of mergers unfold.

JEL Codes: C72, G21, G28, L13, L41, L51

# 1 Introduction

For most of the twentieth century, the structure of the U.S. banking system remained largely unchanged. However, in the last quarter of the century it underwent a major transformation. Much work has been devoted to understanding the causes of this change and its effects. According to Berger et al. (1995), these changes are linked to two major innovations: (i) regulatory changes, from deposit deregulation in the early 1980s to deregulation of branching and banking activities a decade later, and (ii) innovations in technology, information processing, derivatives, and loan securitization, among others.

This rapid structural change in the U.S. banking industry has been characterized by consolidation in commercial banking (the number of commercial banks decreased by one-third between 1985 and 1994) and by concentration of assets among the largest banking organizations.

There are, however, some remaining puzzles about the consolidation process. According to the literature, there are two main motives behind banking consolidation: (i) value maximization, such as economies of scale, economies of scope, and risk diversification, and (ii) other motives, such as self-serving interests of managers. Extensive research on the effects of consolidation has found evidence of profit efficiency (Berger, 1998), but no evidence of economies of scale (Berger et al., 1999) or economies of scope (Stiroh, 2004). As a consequence, there are no improvements in cost efficiency. However, these findings conflict with the opinions expressed by bank managers, who cite gains in cost efficiency as the main motive for consolidation. As Jones and Critchfield (2005) state, the lack of economies of scope and scale in the consolidation of the U.S. banking system represents a fairly substantial puzzle.

This paper sheds light on this puzzle by focusing attention on the strategic incentives created by the geographic deregulation of the banking industry. Our results suggest that relaxation of constraints on the geographic presence of U.S. banks is responsible for the consolidation of the U.S. banking industry, regardless of value-maximizing motives. We set forth a theoretical model of banking competition in which to characterize banks' strategic responses to geographic deregulation. We then show that even in the absence of economies of scale and scope, bank mergers represent optimal responses nevertheless. Further, we show that the consolidation process is characterized by merger waves and that some equilibrium mergers are not profitable per se -they yield losses- but become profitable as the waves of mergers unfold.

Historically, U.S. banks were constrained from crossing state lines by the MacFadden Act of 1927, and from establishing branches across county lines by state laws. By

1975, no state allowed out-of-state bank holding companies (BHCs) to buy in-state banks. By 1990, all states but Hawaii allowed out-of-state BHCs to buy in-state banks, and all but three states allowed state-wide branching. These developments marked a deregulatory process that was completed with the passage by Congress of the Riegle-Neal Interstate Banking and Branching Efficiency Act (IBBEA) in 1994. Implemented in June 1997, IBBEA removed all remaining federal restrictions on interstate banking and encouraged states to permit interstate branching. (See Kroszner and Strahan, 1999, for a detailed chronology of deregulatory changes at the state level)

The effects of deregulation on the geographic expansion of U.S. banks have been extensively analyzed from an empirical point of view. However, to our knowledge, Economides et al. (1996) is the only paper that attempts a theoretical approach to deregulation; it does so from the point of view of attempting to uncover regulators' motivations for protecting small banks from entry by large corporations.

We borrow from Economides et al. (1996) the monopolistic competition model à la Salop (1979), modeling the deregulatory process as an incumbent–entrant game with several markets. Following announcement of unrestricted banking and branching nationwide at a given future date, incumbents in a given market must decide whether to fight or accommodate entry by potential entrants. The novelty of this approach is that all banks are incumbents in some markets and entrants in others. We keep our version of the model particularly simple, especially with respect to the cost function. Given that there is no empirical evidence of economies of scope or scale in the U.S. consolidation process, we do not include them in our cost function.

In a first version of the model we do not allow mergers and acquisitions, in order to analyze the strategic responses of incumbents and entrants to the deregulatory process. We find that in equilibrium, incumbents expand their branch networks, although not enough to deter entry. As a result, each market experiences an increase in the number of branches. The exact number of new branches depends upon the particular values of the parameters, although two relevant predictions are parameter-free. The first of these is that after deregulation, half of each market is still controlled by the former incumbent, whereas the other half is shared by the entrants. This implies a 3-bank concentration ratio equal to one-half plus the inverse of the number of entrants in the market. The second is that banking institutions that, in the regulated period, were incumbents in richer markets, enjoy larger branch networks and higher profits once geographic restrictions are lifted.

We next enlarge the model by including a merger and acquisition stage in our game. We borrow this stage from Qiu and Zhou (2007), which develops a model of

endogenous mergers in the context of Cournot competition. The aim of this second version of the model is to study whether mergers, even in the absence of economies of scale and scope, could form part of an optimal strategy. Our results are notable. We find that mergers are indeed an optimal response and whenever a merger occurs in equilibrium, a complete merger wave is predicted. It is interesting that some of these equilibrium merger waves are initiated for strategic reasons; i.e., they are not profitable per se for the merging institutions but later become profitable because they trigger further mergers.

Finally, the effects of asymmetric state-level regulation on the evolution of the banking system are discussed.

We believe that our paper explains the main features of the recent evolution of the U.S. banking system. However, the literature offers some alternative explanations. Some claim that scale economies exist but that the methodology used to find them is not adequate. See for example, Hughes et al. (2001), which finds scale economies based on the role of the bank as an intermediary. Other explanations resort to managerial motives to explain why some mergers yield negative profits. For example, Gorton et al. (2009) explain this by assuming that managers derive private benefits from operating a firm beyond the value of that firm.

In our model, the consolidation process is triggered by the announcement of full deregulation of geographic expansion. Banking institutions anticipate an increase in competition. This anticipated competition stimulates mergers, even if they yield negative profits in the short-term. This is because mergers soften the competitive pressure faced by the acquiring bank, by reducing both the number of entrants in its own markets and the number of rival entrants in new markets. Further, we show that one merger is followed by another, and that one by another, and so on, turning any unprofitable merger (if any) into a profitable one as the merger wave develops.

Our conclusions endorse the ideas of Berger (1998), which observes that "many of the merger participants in the 1980s focused on expanding their geographic bases to gain strategic long-run advantage by getting footholds in new locations, rather than on reducing costs or raising profits in the short run. Merger participants in the 1990s appear to be more focused on cutting costs..." We however, believe that the strategic explanation can be extended to most of the 1990s, as full deregulation was implemented in June 1997 by the IBBEA.

The remainder of this paper proceeds as follows. Section 2 sets forth the basic model, which is solved in Section 3. Mergers and acquisitions are considered in Section 4. Section 5 presents our conclusions.

## 2 The Branching Deregulation Game

We assume that there are  $K + 1$  territories and  $K + 1$  banking institutions, each initially operating as a monopolist in its own territory (one branch per territory). The regulatory agency announces that at a given date, cross border activity will be allowed. We model the Branching Deregulation Game as an incumbent–entrant model. The timing of the game is set forth in the following definition.

**Definition 1** *The timing of the Branching Deregulation Game is as follows:*<sup>1</sup>

**Stage 1.** *Incumbents decide simultaneously the number of branches to open in their own territories;*

**Stage 2.** *Upon observing incumbents' decisions in Stage 1, entrants decide simultaneously how many branches to open in new territories; and*

**Stage 3.** *Price competition takes place in each territory.*

Banking institutions use two strategic variables: branch networks and interest rates. In this paper, we consider a dynamic model in which the long-term variable is the branch network, whereas the short-term strategic variable is price (interest rates).

Note that a given banking institution faces a complex problem as it acts as incumbent in one territory and as entrant in  $K$  territories, so it needs to take  $2K + 2$  decisions. In order to simplify the problem, we assume that:

- (i) the territories are isolated from each other -we do not allow customers to fulfill their banking needs outside their territory; and
- (ii) the cost function depends in a linear fashion on the total number of branches open throughout all territories. We purposely neglect other cost variables.

These two assumptions cause decisions in one territory to be independent of decisions in other territories. Hence, we focus on competition in one arbitrary territory.

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<sup>1</sup>The Branching Deregulation Game is a stylized version of U.S. branching deregulation. One missing feature is the opt-out option that the IBBEA permitted regarding the opening of de novo branches by out-of-state banks. In our game, banks are free to open as many de novo branches as they wish. We later discuss the role of this assumption.

### 3 Equilibrium of the Branching Deregulation Game

We solve for the subgame perfect equilibrium of the Branching Deregulation Game. The Branching Deregulation Game has three types of subgame: (i) price competition subgames, (ii) entry subgames, and (iii) incumbent subgames. Inductive arguments apply.

#### 3.1 Price competition subgames

Following Economides et al. (1996), we model competition using Salop's spatial model (1979). Given that we are interested in analyzing geographic deregulation, we simplify the model by assuming that banks compete on deposits and that transportation costs are at infinity. Under this condition, customers optimally take their deposits to the closest branch, independent of interest rates. The Nash equilibrium strategy in this subgame is that all banks will set their deposit interest rates equal to zero. With the additional assumption of symmetric location of branches, profits of banking institution  $i$  in territory  $k$  amount to

$$\Pi_{i,k} = n_{i,k} \left( \delta_k \tilde{r} \frac{1}{n_k} - \Phi \right)$$

where  $\delta_k$  represents market  $k$  density,  $\tilde{r}$  is market interest rate,<sup>2</sup>  $n_{i,k}$  is the number of branches opened by banking institution  $i$  in market  $k$ ,  $n_k$  is the total number of branches (of all banking institutions) in market  $k$ , and  $\Phi > 0$  represents cost per branch opened. Let  $\varepsilon_k = \frac{\Phi}{\delta_k \tilde{r}}$  be the relative cost per branch opened in territory  $k$ .

#### 3.2 Entry subgames

We step back now and address entry subgames. In this class of subgame, entrants decide on the number of branches to open in territory  $k$ , after observing the number of branches opened by the incumbent.

**Lemma 1** *Let  $I$  be the number of branches opened by the incumbent in territory  $k$ . In the entry subgame, the optimal number of branches opened by each entrant is*

$$e_k^*(I) = \begin{cases} \frac{K(1-2\varepsilon_k I) - 1 + \sqrt{(K-1)^2 + 4K\varepsilon_k I}}{2K^2\varepsilon_k} & \text{if } I < \frac{1}{\varepsilon_k} \\ 0 & \text{if } I \geq \frac{1}{\varepsilon_k} \end{cases}$$

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<sup>2</sup>We assume that banks, regardless of their territory, can access the same market interest rate.

**Proof of Lemma 1.** Let the entrant  $i$  open  $e$  branches and the remaining  $K - 1$  entrants open  $m$  branches on aggregate. Then, entrant  $i$ 's profits in market  $k$  are

$$\Pi_{i,k} = \delta_k \tilde{r} e \left( \frac{1}{I + e + m} - \varepsilon_k \right)$$

where  $I$  is the number of branches opened by the incumbent. The first order condition is

$$\frac{\partial \Pi_{i,k}}{\partial e} = \delta_k \tilde{r} \frac{m + I - \varepsilon_k (m + e + I)^2}{(m + e + I)^2} = 0$$

By imposing symmetry, i.e.,  $m = e(K - 1)$  and solving for  $e^*$  we get

$$e_k^*(I) = \frac{K(1 - 2\varepsilon_k I) - 1 + \sqrt{(K - 1)^2 + 4K\varepsilon_k I}}{2K^2\varepsilon_k}$$

It is easy to show that the optimal number of branches opened by each entrant is decreasing in  $I$  and that it is null when the incumbent opens  $\frac{1}{\varepsilon_k}$  branches.  $\square$

From the above proposition, a number of corollaries follow:

**Corollary 1** (i)  $e_k^*(0) > 0$   
(ii)  $\frac{\partial e_k^*(I)}{\partial I} < 0$   
(iii)  $\frac{\partial e_k^*(I)}{\partial K} < 0$

It is evident that entry is not blocked, although it can be prevented by the incumbent upon opening  $\frac{1}{\varepsilon_k}$  branches. Also, there is an inverse relationship between branches opened by incumbents and branches opened by entrants (strategic substitutes) and between the number of branches opened by entrants and the number of territories.

### 3.3 Incumbent subgames

Finally, we analyze the incumbent subgames. Recall that there is only one incumbent per territory. In this class of subgame, incumbents decide on their own optimal opening of branches anticipating the optimal behavior of entrants described in Lemma 1.

**Lemma 2** *The optimal number of branches opened by the incumbent of territory  $k$  is  $I_k^* = \frac{2K-1}{4K\varepsilon_k}$ .*

**Proof of Lemma 2.** The profits to incumbent  $i$  in territory  $k$  from opening  $I$  branches are

$$\Pi_{i,k} = \delta_k \tilde{r} I \left( \frac{1}{I + K e^*(I)} - \varepsilon_k \right)$$

First order condition yields

$$\frac{\partial \Pi_{i,k}}{\partial I} = -4K^2 \varepsilon_k^2 I^2 (-2K + 4K \varepsilon_k I + 1) \delta_k \tilde{r} = 0$$

And solving for  $I^*$  we get

$$I_k^* = \frac{2K - 1}{4K \varepsilon_k}$$

□

Some properties of the optimal number of branches opened by the incumbent are contained in the following corollary:

**Corollary 2** (i)  $0 < I_k^* < \frac{1}{\varepsilon_k}$   
(ii)  $\frac{\partial I_k^*}{\partial K} > 0, \frac{\partial I_k^*}{\partial \varepsilon_k} < 0$   
(iii)  $\lim_{K \rightarrow \infty} I_k^* = \frac{1}{2\varepsilon_k}$

In equilibrium, entry is not prevented but accommodated by the incumbent, as the expansion of the branch network in its own territory is smaller than  $\frac{1}{\varepsilon_k}$ . This expansion is inversely proportional to the relative cost per branch and increasing in the number of territories.

We can now set forth the equilibrium outcome of the Branching Deregulation Game.

**Proposition 1** *In equilibrium, for territory  $k$ ,*

- (i) *the incumbent opens  $\frac{2K-1}{\Phi} \frac{\tilde{r}}{4K} \delta_k$  branches with profit  $\frac{\tilde{r}}{4K} \delta_k$*
- (ii) *each entrant opens  $\frac{2K-1}{\Phi} \frac{\tilde{r}}{4K^2} \delta_k$  branches with profit  $\frac{\tilde{r}}{4K^2} \delta_k$*
- (iii) *The 3-bank concentration ratio is  $\frac{1}{2} + \frac{1}{K}$*

**Proof of Proposition 1.** The proof follows immediately from Lemmas 1 and 2. □

It is important to note that the number of branches opened by the different banking institutions in each market depends on the parameters of the model, i.e., number of territories, market densities and cost parameters. For example, the total number of branches opened in territory  $k$  is  $\frac{2K-1}{2K} \frac{\tilde{r}}{\Phi} \delta_k$ , which is proportional to market density.

However, the market structure is parameter-free in equilibrium: Each incumbent gets a market share of 50% in its own territory (measured either in terms of branches or in terms of profits), whereas the remaining 50% is shared equally among the entrants. This implies that one-half is a lower bound for the 3-bank concentration ratio.

To conclude the equilibrium analysis of the Branching Deregulation Game, we focus on the equilibrium behavior of a given banking institution. Recall that a bank acts as incumbent in one territory and as entrant in  $K$  territories; we next compute branch network size and profits to banking institution  $k$ , incumbent of territory  $k$

$$N_k = \frac{2K-1}{4K} \frac{\tilde{r}}{\Phi} \delta_k + \sum_{j \neq k} \frac{2K-1}{4K^2} \frac{\tilde{r}}{\Phi} \delta_j = \frac{2K-1}{\Phi} \frac{\tilde{r}}{4K^2} \left[ (K-1) \delta_k + \sum_{i=1}^K \delta_i \right]$$

$$\Pi_k = \frac{\delta_k \tilde{r}}{4K} + \sum_{j \neq k} \frac{\delta_j \tilde{r}}{4K^2} = \frac{\tilde{r}}{4K^2} \left[ (K-1) \delta_k + \sum_{i=1}^K \delta_i \right] = \frac{\Phi}{2K-1} N_k$$

It is important to stress that the size of the branch network and the profits of the various banking institutions are not symmetric and that they mimic the market density distribution of territories, as the following proposition shows.

**Proposition 2** *For two territories  $k, k'$ , with  $\delta_k > \delta_{k'}$ , (i) the incumbent of territory  $k$  opens a total number of branches (in all territories including its own) larger than the incumbent of territory  $k'$  and (ii) it obtains larger profits in equilibrium.*

**Proof of Proposition 2.** The incumbent of territory  $k$  and the incumbent of territory  $k'$  open the same number of branches and derive the same profits in territories other than  $k$  and  $k'$ . Hence, any difference in branches and profits must stem from behavior in territories  $k$  and  $k'$ . In fact, this difference favors the incumbent of the territory with the higher density, as Proposition 1 states.  $\square$

If we now identify higher deposit-market densities with wealthier territories, then Proposition 2 has an economically relevant interpretation: banking institutions from richer territories enjoy larger branch networks and higher profits once deregulation is completed.

## 4 Mergers and Acquisitions

In the previous section, we did not allow banks to merge and/or acquire in territories other than their own. In this section, and following the history of the U.S. deregulation process, we assume that prior to full deregulation, banks can operate in other territories via mergers and acquisitions through bilateral, interstate agreements.

We need to add a mergers and acquisitions (M&A) stage to our model, as Stage 0. Our model builds on the merger protocol considered in Qiu and Zhou (2007) in the context of Cournot competition. This protocol is particularly elegant, as it imposes no pre-specified order on who proposes M&A first, and it imposes no restrictions on which parties are to be merged.

Mergers take place sequentially in multiple rounds, one round for each merger. At the beginning of each round, a bank is selected as proposer. The proposer can either pass or offer a merger. If the proposer passes, a new bank is selected to act as merger proposer. If all active banks pass, the M&A stage ends and the game proceeds to stage 1.

If the proposer offers a price to acquire another bank (respondent), the latter can either accept or reject. If the respondent accepts, then the merger takes place (and the price is paid) and the merger game proceeds to the next round, in which the number of active banks is reduced by one but the merged bank is larger and acts as incumbent in all the territories of its constituent banks.

If the respondent rejects, the M&A stage ends and the game proceeds to stage 1.

Assume that the M&A stage has ended and that there are  $n$  active banks. We assume from the outset that full monopolization of the banking sector is not permitted and therefore  $n \geq 2$ . Let  $\mathcal{K} = \{1, \dots, K + 1\}$  be the set of territories and  $\mathcal{K}_i \subset \mathcal{K}$  be the set of territories in which bank  $i$  acts as incumbent (this is a partition of the set of territories among the  $n$  active banks). Then, following the equilibrium analysis of the Branching Deregulation Game, the benefit to bank  $i$  is the sum of the benefits from the territories in which it acts as incumbent and from the territories where it enters, i.e.,

$$\Pi_i = \frac{\tilde{r}}{4(n-1)^2} \left[ (n-2) \sum_{k \in \mathcal{K}_i} \delta_k + \sum_{k \in \mathcal{K}} \delta_k \right]$$

Let  $\alpha_i$  denote the percentage of total market density in which bank  $i$  is incumbent, i.e.,  $\alpha_i = \frac{\sum_{k \in \mathcal{K}_i} \delta_k}{\sum_{k \in \mathcal{K}} \delta_k}$  and normalize  $\Pi_i$  by dividing by  $\tilde{r} \sum_{k \in \mathcal{K}} \delta_k$ . This yields the so-called normalized profits:

$$\hat{\Pi}_i(n, \alpha_i) = \frac{1 + (n-2)\alpha_i}{4(n-1)^2}$$

Below, we work with normalized profits. Two points are worth mentioning:

- Profits to a given bank are decreasing in the number of active banks  $n$ . This is the free-rider effect associated with mergers, first noted by Salant, Switzer and

Reynolds (1983) in Cournot competition.

- Profits to a given bank do not depend on the number of territories in which it is incumbent, but on the size of the fraction of the pie in which the bank acts as incumbent,  $\alpha_i$ . As a matter of fact, this relationship is linear and increasing.

We focus on the subgame perfect equilibrium of the M&A stage. We now describe results pertaining to the M&A stage.

The first result relates to the acquisition price in an equilibrium merger. Given that a take-it-or-leave-it bargaining process over the surplus generated by a merger is assumed, the respondent must be indifferent between accepting or rejecting the price. Therefore, in a round with  $n$  active banks, bank  $j$  will be acquired in equilibrium at price  $\hat{\Pi}_j(n, \alpha_j)$ .

With the help of merger acquisition prices, a merger can be classified as either *myopic* or *strategic*. A merger is myopic if the acquisition price of the merged bank  $\hat{\Pi}_{i+j}(n-1, \alpha_i + \alpha_j)$  exceeds the sum of the acquisition prices of the two merging banks  $\hat{\Pi}_i(n, \alpha_i) + \hat{\Pi}_j(n, \alpha_j)$ . A myopic merger is profitable per se, that is, if in the next round the merged bank is acquired by a third party or the M&A process stops, the merger generates a positive surplus. A non-myopic merger is termed strategic because if it happens in equilibrium, the merging institutions expect some future event to occur that is different from being acquired and from the M&A process ending; that is, they expect other mergers to happen in the future that render profitable their own merger.

The next lemma characterizes myopic mergers.

**Lemma 3** *The merger  $i + j$  is myopic if and only if  $\alpha_i + \alpha_j \geq \hat{c}_0(n)$ , where  $\hat{c}_0(n) = \frac{n^2 - 6n + 7}{n^2 - 5n + 5}$ .*

**Proof of Lemma 3.** The proof makes use of the definition of myopic mergers.

$$\begin{aligned} \hat{\Pi}_{i+j}(n-1, \alpha_i + \alpha_j) &\geq \hat{\Pi}_i(n, \alpha_i) + \hat{\Pi}_j(n, \alpha_j) \\ \frac{1 + (n-3)(\alpha_i + \alpha_j)}{4(n-2)^2} &\geq \frac{2 + (n-2)(\alpha_i + \alpha_j)}{4(n-1)^2} \\ \alpha_i + \alpha_j &\geq \frac{n^2 - 6n + 7}{n^2 - 5n + 5} \end{aligned}$$

□

The analysis of the threshold  $\hat{c}_0(n)$  forms the content of next corollary:

### Corollary 3

(i) For  $n$  smaller than 5,  $\widehat{c}_0(n)$  is negative, implying that all possible mergers are myopic;

(ii) For every  $n$ ,  $\widehat{c}_0(n) < 1$ , implying that for every  $n$  there are configurations for which there exist myopic mergers; and

(iii)  $\widehat{c}_0(n)$  is increasing in  $n$ .

We are now positioned to describe in some detail the equilibrium outcomes of the Branching Deregulation Game with M&A. We consider two cases with respect to the structure of the bilateral agreements signed among territories. First, we assume the existence of a complete network, that is, a situation in which all states have signed bilateral interstate agreements with all other states; in a subsequent analysis, we show how the absence of even one bilateral agreement may affect the equilibrium outcome of the game.

## 4.1 Complete bilateral agreements

Complete bilateral agreements imply that any bank can merge with or acquire any other bank. We now show that the existence of myopic mergers triggers a complete merger wave in a complete setting, as the next proposition states.

**Proposition 3** *If there exists at least one myopic merger in initial configuration  $\{n, (\alpha_i)_{i=1}^n\}$ , then there is a complete merger wave in equilibrium.*

**Proof of Proposition 3.** Let  $\alpha^M$  be the size of the myopic merger. Lemma 3 and Corollary 3 imply that there exists at least one myopic merger in later rounds. This is so because by definition (i) the number of active banks grows smaller as mergers are consummated, and (ii) there are at least two banks for which their merger size is at least  $\alpha^M$ . Once the presence of a myopic merger is assured in any round of the M&A stage, it becomes clear that in equilibrium in any round there must be a merger, because at least two banks have an incentive to merge rather than passing (these are the banks that can engage in a myopic merger).  $\square$

The above proposition does not say that in equilibrium all mergers will be myopic. It simply states that the presence of a myopic merger is a sufficient condition for a merger wave.

We next prove an even stronger statement regarding the equilibrium outcomes of the M&A Stage.

**Proposition 4** *In equilibrium, for every initial configuration  $\{n, (\alpha_i)_{i=1}^n\}$ , either there is no merger at all or a complete merger wave occurs.*

**Proof of Proposition 4.** Assume for the sake of contradiction that there exists a shorter merger wave. We then focus on the last merger. This merger, by Proposition 3 cannot be myopic, otherwise it would trigger a merger wave and therefore could never be the last merger. But if the last merger is not myopic, it cannot be part of any equilibrium, because the merged banks would be better off not engaging in the merger.  $\square$

Let us summarize our findings thus far. We know that (i) there are only two possible equilibrium outcomes: either no mergers at all or a complete merger wave, (ii) the existence of myopic mergers is a sufficient condition for merger waves to occur, and (iii) for any  $n$ , there are initial configurations for which myopic mergers exist. Note that these results do not prove the existence of strategic mergers in equilibrium. The shortest proof is to prove that "no merger" cannot happen in equilibrium. In this way, all configurations with no myopic mergers will contemplate a strategic merger, triggering the merger wave. A direct proof of such negative result would require describing the equilibrium strategy for every banking configuration; however, the strategy sets are quite complex objects in this game. An indirect proof has proven elusive.

Below, we confine our discussion to an existence theorem of strategic mergers in equilibrium for an arbitrarily large number of banks. We already know that if  $n < 5$ , all possible mergers are myopic (cf. Corollary 3). Thus we focus on the case  $n \geq 5$ .

**Proposition 5** *For each  $n \geq 5$ , there exists a configuration  $\{\tilde{n}, (\alpha_i)_{i=1}^{\tilde{n}}\}$  with  $\tilde{n} \in [n, 2n + 1]$  whose merger wave is triggered by a strategic merger in equilibrium.*

**Proof of Proposition 5.** Let  $n \geq 5$  and  $\hat{n} = 2n$ . Consider  $\hat{n}$  banks and banking configuration  $\hat{C} = \{\hat{n}, \hat{\alpha}, \frac{1-\hat{\alpha}}{\hat{n}-1}, \dots, \frac{1-\hat{\alpha}}{\hat{n}-1}\}$ . This configuration considers one bank with size  $\hat{\alpha}$  and each of the remaining  $\hat{n} - 1$  banks with size  $\frac{1-\hat{\alpha}}{\hat{n}-1}$ . Let us also assume that  $\hat{\alpha}$  is such that  $\hat{\alpha} + \frac{1-\hat{\alpha}}{\hat{n}-1} = \hat{c}_0(\hat{n})$ . Given that  $\hat{c}_0(\hat{n})$  is larger than 0.79 for  $\hat{n} \geq 10$ , this banking configuration assumes that there exists one large bank (with size  $\hat{\alpha}$ ) and a fringe set of small banks in the banking system (with aggregate size  $1 - \hat{\alpha}$ ) and that myopic mergers necessarily require the participation of the large bank.

Assume that there are no strategic mergers for any  $\tilde{n} \in [n, \hat{n}]$ . Otherwise, the proposition would be trivially true. Our aim is to show a configuration with  $\hat{n} + 1$  banks for which a merger wave is triggered by a strategic merger.

We focus on symmetric equilibria. There are three possible symmetric equilibrium strategies: (i) no bank passes, (ii) the largest bank passes but not the smallest ones, and (iii) the smallest banks pass but not the largest one. Let us not forget that only

myopic mergers occur in equilibrium, and therefore the target bank in any merger is the largest one for the smallest banks, and any small bank (we assume randomly picked) for the largest one. It is trivial to show that regardless of the equilibrium strategy, the probability that a small bank passes from one round to the next without being involved in any merger is  $\frac{\hat{n}-2}{\hat{n}-1}$ .

Given that any myopic merger gives rise to another highly symmetric configuration of the same sort, i.e., one larger bank and the small ones, again with size  $\frac{1-\hat{\alpha}}{\hat{n}-1}$ , we easily compute the probability that a small bank survives  $t$  rounds without being involved in mergers:  $\frac{\hat{n}-1-t}{\hat{n}-1}$ .

Let us now consider the equilibrium expected payoff for a small bank in configuration  $\hat{C}$ . There are three possible events in a given round: (i) the bank is acquired by the large bank, (ii) the bank acquires the large bank, and (iii) the bank passes to the next round with no involvement in a merger. Any history up to any given round will consist of a succession of these three event types, one for each round.

Of all possible histories up to a given round, the following plays a prominent role in our proof: a small bank surviving  $\hat{n}/2$  periods with no involvement in a merger. Note that this history has probability  $\frac{\hat{n}-1-\frac{\hat{n}}{2}}{\hat{n}-1} = \frac{1}{2} \frac{\hat{n}-2}{\hat{n}-1}$ .

There are of course other possible histories, but they all have positive expected payoffs. We now show why this is so. Some histories involve being acquired in the very first round—the payoff is therefore positive because the bank is paid the reservation value. Other histories entail acquiring the large bank in the first round; the expected payoff attached to such an acquisition is positive because this merger is myopic. The remaining histories begin with passing to the second round with no involvement in a merger. Again, this subset is composed of a history in which the bank is acquired in the second round (with a positive payoff), another history in which the bank acquires the large bank (again with a positive payoff), and finally the remaining histories in which the bank survives with no involvement in a merger.

This argument shows that the equilibrium expected payoff of a small bank in the original configuration is bounded by the expected payoff attached to the event "surviving  $\hat{n}/2$  periods." And we consider the worst-case scenario, being acquired and therefore receiving the reservation payoff,  $\hat{\Pi}_{i+j}(\hat{n} - \frac{\hat{n}}{2}, \frac{1-\hat{\alpha}}{\hat{n}-1})$ .

Consider now initial configuration  $\tilde{C} = \{\hat{n} + 1, \hat{\alpha}, \frac{1-\hat{\alpha}}{\hat{n}-1}, \dots, \frac{1-\hat{\alpha}}{\hat{n}-1}, \alpha_a, \alpha_b\}$  in which one of the small banks in  $\hat{C}$  is split into two smaller banks with sizes  $\alpha_a$  and  $\alpha_b$  such that  $\alpha_a + \alpha_b = \frac{1-\hat{\alpha}}{\hat{n}-1}$ . Notice that given that  $\hat{c}_0(n)$  is increasing in  $n$ , it happens that no merger is myopic in this configuration.<sup>3</sup>

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<sup>3</sup>Note that the size of the largest merger is  $\hat{\alpha} + \frac{1-\hat{\alpha}}{\hat{n}-1} = \hat{c}_0(\hat{n}) < \hat{c}_0(\hat{n} + 1)$

We claim that banks with sizes  $\alpha_a$  and  $\alpha_b$  find it profitable to merge in configuration  $\tilde{C}$ . Note that the expected payoff in equilibrium of the merger in  $\tilde{C}$  is the equilibrium expected payoff of any small bank in configuration  $\hat{C}$ , which we have shown to be bounded below by

$$\Gamma = \frac{\hat{n} - 2}{2(\hat{n} - 1)} \hat{\Pi}_{a+b} \left( \hat{n} - \frac{\hat{n}}{2}, \frac{1 - \hat{\alpha}}{\hat{n} - 1} \right) = \frac{1}{4} \frac{2\hat{n}^2 - 9\hat{n} + 6}{(\hat{n} - 2)(\hat{n} - 1)(\hat{n}^2 - 5\hat{n} + 5)}$$

We need to show that this payoff is larger than the opportunity cost of the merger, which is

$$\Omega = \hat{\Pi}_a(\hat{n} + 1, \alpha_a) + \hat{\Pi}_b(\hat{n} + 1, \alpha_b) = \frac{1}{4} \frac{(\hat{n} - 3)(2\hat{n} - 3)}{\hat{n}^2(\hat{n}^2 - 5\hat{n} + 5)}$$

This is actually the case, as follows

$$\Gamma - \Omega = \frac{1}{4} \frac{(45\hat{n} - 18) + 2\hat{n}^2(3\hat{n} - 17)}{\hat{n}^2(\hat{n} - 2)(\hat{n} - 1)(\hat{n}^2 - 5\hat{n} + 5)} > 0 \text{ for } \hat{n} \geq 10$$

We therefore show that in configuration  $\tilde{C}$  "no merge" is not an equilibrium outcome. It then follows from Proposition 4 that a merger wave necessarily occurs, and given that there are no myopic mergers, the claim follows.  $\square$

The next subsection discusses equilibrium results when not all territories have signed bilateral agreements.

## 4.2 Incomplete bilateral agreements

We now consider situations in which some bilateral interstate agreements have not been signed. We refer to these situations as an incomplete network of bilateral agreements. Our aim is to illustrate the effect of the incomplete nature of the network on the M&A Stage.

Our first observation is that the structure of the incomplete network does not alter the myopic nature of a given merger, because a myopic merger is defined in terms of profits, which depend on the number of banking institutions and the percentage of the total market densities of the merging institutions. Also note that these two latter variables are independent of the features of the incomplete network.

A second observation is that once the M&A stage ends, it cannot be that a myopic merger is left uncompleted, unless there is no bilateral agreement signed between the involved territories.

These two observations together reveal that for those banking configurations in which there are myopic mergers, if a myopic merger is allowed by bilateral agreement,

it necessarily triggers a merger wave that will eventually be stopped by binding legal restrictions imposed by the incomplete network.<sup>4</sup> This point highlights the direct effect of the incompleteness of bilateral agreements.

A less obvious effect is the interaction between strategic mergers and incomplete networks. To illustrate this point, we use the example from Proposition 5. There, configuration  $\tilde{C}$  is such that no myopic mergers exist but a merger wave, necessarily triggered by a strategic merger, occurs in equilibrium. Assume now that some of the required subsequent mergers that make profitable the initial strategic merger cannot take place due to the lack of agreements. In such case, the initial merger, while legally possible, does not occur. This is the indirect effect of the structure of the agreement network on the functioning of the banking system.

## 5 Conclusion

This paper develops a stylized model that captures the geographic deregulation process of the U.S. banking industry. In this model, we investigate the incentives of banking institutions to enter new markets as well as to merge, as a result of branching deregulation. A number of qualitative results follow from the model. We show that these results agree with most of the empirical evidence of the last three decades on the U.S. banking industry consolidation process.

First, the number of banking institutions is reduced but the number of branches increases (see Berger, 1998). Second, the 3-bank concentration ratio is bounded below by one-half. This ratio is inversely related to the number of entrants in each market (see data from the Federal Reserve Board). Third, banks from richer territories become the largest banking organizations in the economy (see Stiroh and Strahan, 2003). Finally, even in the absence of economies of scale (see Berger et al., 1999) and economies of scope (see Stiroh, 2004), mergers nevertheless may represent an optimal response and occur in waves (see Berger, 1998).

Our model allows mergers and acquisitions prior to full deregulation, but we do not consider the possibility of post-deregulation mergers. Hence, our model explains merger activity in the U.S. banking industry up to 1997. We are fully aware that mergers did not stop in that year. We could accommodate subsequent mergers in our analysis by including an additional stage in the model, but this would overly complicate the model.

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<sup>4</sup>Recall that if a merger between two institutions is myopic, then the subsequent merger between the merging institution and any other bank will also be myopic.

We offer one intuition: Our model imposes de novo branches throughout all markets after deregulation, and based on that assumption, banks optimally merge prior to deregulation. In the U.S., the IBBEA permits states to opt-out of interstate branching and in fact, many states did protect their banks by denying de novo entry to out-of-state banks. Hence, entrants were forced to buy existing branches. If bank expectations about future de novo branches are not fulfilled in our model, the optimal reaction would be to merge with existing banks as a means to enter new markets.

A rigorous analysis of mergers in the post-deregulation era is left for future research.

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