A Markov View of Bank Consolidation: 1960-2000

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Abstract

This paper presents an empirical investigation of the consolidation process among banking organizations over the past 40 years. As merger announcements in the news make clear, consolidation is a continuing saga. While consolidation has been the dominant characteristic of the banking industry for decades, tests show that consolidation has not been a stable process. These tests indicate that nine different episodes, ranging in duration from one year to 11 years, describe the bank consolidation process since 1960. Closer examination of the episodes reveals that consolidation slowed after the early 1980s for banks with less than $2.7 billion in assets, but accelerated and was operating at its fastest pace between 1994 and 2000 for banks with more than $2.7 billion in assets. Furthermore, in the 1994-2000 episode, the largest banks, those with assets greater than $24.3 billion were most likely to exit the industry while the smallest banks, those with assets of less than $100 million, were least likely to exit the industry. Transition probabilities from the most recent consolidation episode provide a plausible estimate of what the banking industry's structure will look like in the future.

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1. Introduction

Regular news reports of the latest merger make it clear that consolidation in the banking industry is a continuing saga. Because consolidation has affected banking organizations of all sizes throughout the United States, it has in some way touched the vast majority of American consumers and businesses that do business with banks. Because of its pervasive effects, bank consolidation continues to draw interest.

Consolidation, characterized by a decline in the number of institutions through mergers or failures and increased concentration of industry assets among the largest institutions, has been part of the banking landscape for the past 30 years. Nonetheless, banking research has paid little attention to how the rate of consolidation has changed over time.[1] While studies have examined the causes and consequences of consolidation, few have considered how much consolidation has accelerated or slowed at different times during the past 40 years or what conclusions we can draw from these changes. This is true even though the rate of consolidation is of fundamental interest to policy makers and bankers alike as a measure of how the industry is responding to legislative, technological, and other changes.

This paper reintroduces a parsimonious technique for tracking changes in the rate of consolidation in the banking industry.[2] This technique uses the Markov chain model to estimate the probabilities that a bank will remain in the same size class from one year to the next, move to a different size class, or leave the industry altogether. A likelihood ratio test then determines whether these estimated transition probabilities are constant from year to year. If the test accepts

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[1] We measure the rate of consolidation as the probability that an institution will leave the industry within the next year.

[2] The terms bank and banking organization both refer to institutions at the highest holding company

the hypothesis that the matrix of transition probabilities is stationary over several periods, then this transition matrix describes the consolidation process over as many years. If the test rejects the hypothesis, then the transition matrices differ over time and comparing the different transition matrices indicates how the rate of consolidation has changed over time.

Although the banking industry has been consolidating for most of the last four decades, the Markov model shows that this consolidation has not been a steady process. The likelihood ratio tests for stationary transition matrices indicate that nine different episodes describe the consolidation process in banking between 1960 and 2000. The duration of the stationary episodes, which range from one year to 11 years, averages four years.

Differences in transition probabilities across episodes reveal a great deal of information about the changing nature of consolidation. Comparisons across the nine episodes reveal that since the early 1980s the rate of consolidation has slowed for banks with less than $2.7 billion in real assets, but has accelerated for banks with over $2.7 billion in assets.[3] Furthermore, in the most recent episode, which began in 1994, the largest banks, i.e., those with assets of at least $24.3 billion, were most likely to exit the industry while the smallest banks, those with assets of less than $100 million, were least likely to exit the industry. Although the smallest banks currently have the lowest exit probability, because there are thousands of small banks they still account for the vast majority of departures each year. For instance, of the roughly 3,300 banking organizations that left the industry between 1994 and 2000, 62 percent had less than $100 million in assets and 96 percent had less than $900 million in assets.

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level, either independent banks or top-tier bank holding companies

[3] Throughout the paper, assets are in real terms. Real assets are total nominal assets divided by the GDP deflator, 1996=100.

Many observers of the banking industry pay particular attention to how consolidation affects community banks. Community banks, which we define as having approximately $3 billion or less in assets, receive particular attention in part because deregulation may have unleashed synergies that are more advantageous to larger banks. Community banks also receive attention because of the dramatic decline in their population. The increasing concentration of assets has engendered concerns about the availability of financial services to small customers and small businesses. Although consolidation has touched banks of all sizes, community banks have received a great deal of attention from economists.[4]

Transition matrices not only allow comparisons among banks of different sizes and across episodes of consolidation, but they also provide a mechanism for making reasonable short-term projections of the future size distribution of banks. Applying transition probabilities from the most recent stationary episode to the current size distribution of banks gives an estimate of the next period's size distribution. Repeating the procedure k times yields a projection of the k-step ahead size distribution. Because consolidation episodes tend to be of relatively short duration, i.e., four years on average, we limit projection horizons to just seven years. Projections based on the 1994-2000 transition matrix suggest that, while several thousand community banks will continue to operate in the United States, the vast majority of banks exiting the industry will continue to come from this population of small community banks.

The remainder of the paper is organized as follows. The following section describes some of the legislative and other changes that have affected consolidation since 1960. Section

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[4] See Hughes, Lang, Mester, and Moon (1999) for a discussion of how consolidation has affected the financial performance of banks. See Jayaratne and Wolken (1999), DeYoung, Goldberg, and White (1999), and Berger, Saunders, Scalise, and Udell (1998) for recent studies of how consolidation has

three describes the Markov methodology and how to test for stationarity of the transition matrix, section four describes the data, section five presents the Markov transition matrices and likelihood ratio tests, section six provides estimates of the future size distribution of the U.S. banking industry, and section seven concludes.

2. Changes in Banking

Studies generally agree about the causes of consolidation. In a recent comprehensive survey of the consolidation literature, Berger, Demsetz, and Strahan (1999) identify five factors: technological progress, deregulation, excess capacity, international consolidation of markets, and the improved financial condition of the banking industry.[5] These findings are much the same as those of earlier studies of consolidation by Berger, Kashyap, and Scalise (1995), Hannan and Rhoades (1992), and Boyd and Graham (1991). These earlier studies focused mostly on how geographic deregulation opened restricted markets to new competition and how technological innovations made rapidly expanding institutions feasible to manage.

The deregulation of geographic markets has been a principal factor driving consolidation. In 1960, roughly two-thirds of all states had some restrictions on intrastate branching, and interstate branching was essentially nonexistent. Beginning in the 1970s, states with branching restrictions gradually relaxed their rules and allowed intrastate and interstate branching. The relaxation of branching restrictions culminated in the Riegle-Neal Interstate Banking and Branching Efficiency Act of 1994, which permits nationwide branching unless a state chooses to

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affected credit availability to small firms.

[5] See also Milbourn, Boot, and Thakor (1999) and Hadlock, Houston, and Ryngaert (1999) for a discussion of the role managerial incentives may play in bank acquisitions.

exempt itself. The relaxation of branching restrictions opened markets to increasing competition and paved the way for banks to grow dramatically larger as they expanded across broad geographic regions.

While geographic deregulation may have opened the door to expansion, technological innovations made it feasible for bankers to manage their expanding operations. Technological change introduced machines that automated back-office operations and computers that allowed managers to quickly process and disseminate information. To appreciate how quickly technology has changed the banking industry since 1960, one need simply note that using magnetic ink for check processing began in 1962. Magnetic ink was important for check processing, but its greatest long-term significance may have been that its introduction meant that for the first time each bank account needed an account number rather than just an individual's name. This numbering of accounts set the stage for dramatic changes at the dawn of the digital era.

With such fundamental technological and regulatory changes removing barriers to competition, it is not surprising that the banking industry began to consolidate. Between 1960 and 2000, the number of banking organizations in the United States fell by nearly half: from 12,805 in 1960 to 6,750 at the end of 2000, with almost all of the population decline taking place after 1980. Banking markets continue to adjust to legislative and technological changes, and as a consequence the banking industry continues to consolidate.

Although consolidation has affected banks of all sizes, small community banks have borne the brunt of consolidation with respect to a diminished population. While mergers and failures have occurred throughout the banking industry, only the smallest banks, those with less than $100 million in assets, have seen their numbers decrease substantially. Table 1 shows that since 1960, the number of banking organizations has actually increased in all other size categories.[6] While the number of banking organizations with less than $100 million in assets fell more than 10 percent between 1960 and 1980, the number of banks in each of the other size categories either doubled or tripled. Even when the total number of institutions began to fall rapidly after 1980, the number of institutions in several size categories continued to rise. At the same time, the number of institutions with less than $100 million in assets fell by more than half.

As the number of small institutions declined, the average banking organization grew larger. In 1960, the average banking organization had just $90 million in assets after adjusting for inflation. The average institution had grown to $209 million by 1980 and to $739 million at the end of 2000. While the average size approaches $1 billion, the median size remains well below $100 million, reflecting the still large number of small institutions. The median size of a banking organization in 2000 was $75 million, compared with $39 million in 1980 and $17 million in 1960.

Although banking is consolidating, it is not a shrinking industry. Industry assets grew from $1.2 trillion in 1960 to $2.6 trillion in 1980 and $5 trillion by the end of 2000. As banking continues to grow and consolidate, the size distribution of banks continues to change. The

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[6] The size categories used in the study and shown in table 1 reflect a desire to maintain a consistent interval to each size class. In order to maintain a consistent width to each interval, the top of each size category is three times the top of the previous size class. Section 4 provides a more complete description of data used in the study.

Markov model and its accompanying transition matrix provides a useful tool for examining just how the size distribution of banks is changing as the industry continues to consolidate.

3. The Markov Chain Model

The Markov chain model provides a simple technique for tracking a variable as it moves from one state to another over time. In this study, the Markov model tracks changes in the size of banking organizations as they move from one size class to another over time. A simple Markov chain model assumes that the transition probabilities underlying the movement of the variable are constant over time. The model then uses an unweighted average of observed transition frequencies over the sample period to estimate the probability that an observation will move from one class to another in the following period. Applying this model to annual changes in the size structure of the banking industry, the Markov model estimates the probability that a bank in one size class will be in another size class within a year. This study then uses a likelihood ratio test to test the stationarity assumption, i.e., that the transition probabilities are constant over time.

One may construct the Markov model in the following manner. Following the example of Quah (1993), let F_t be the size distribution of commercial banking organizations in the United States in period t. [7] The size distribution evolves as

$$F_{t+1} = M' F_t , \tag{1}$$

where M is the transition probability matrix corresponding to F. The researcher can partition F into any number of intervals or classes. In this study, in order to maintain a consistent scale

[7] The discussion of Markov chains also draws from Isaacson and Madsen (1976) and Williams (1979).

within each interval, each partition represents an asset size class where the top of each partition is three times the size of the top of the previous partition. Each class then corresponds to a column and row of the transition matrix, M. Thus, if F has five size classes, M will be a five-by-five matrix whose elements p_{ij} represent the probability that a bank in class i during period t will be in class j in period (t+1). For instance, p_{21} (second row, first column of M) is the probability that a bank in class two this period will be in class one next period.

Two important assumptions underlie the simple first-order form of the Markov model represented by equation 1.[8] Applied to this study, the first assumption is that changes in bank size satisfy the Markov property, where a stochastic process satisfies the Markov property if for every t and all classes i_1, i_2,..., i_n it is true that

$$P[X_t = i_n \mid X_{t-1} = i_{n-1}, X_{t-2} = i_{n-2}, \dots, X_1 = i_1] = P[X_t = i_n \mid X_{t-1} = i_{n-1}] . \qquad (2)$$

The Markov property of equation 2 means that the transition probability for a bank in period t depends only on the bank's class in period (t-1) and is independent of the bank's class in any period earlier than (t-1). The Markov property rules out the possibility that momentum will have a role in determining future states of the process. In this study, the Markov property requires that a bank=s transition probability depends only on the bank=s current size and not on its size two or more years ago. This is a reasonable assumption regarding banks. The Markov property is what allows equation 1 to be written as a first-order process.

[8] Two other Markov model assumptions apply as well: the variable must be a discrete-time stochastic process with a countable state space. As the variable, bank size measured by assets (countable) at the end of each year (discrete-time) satisfies these two assumptions.

The second assumption is that the Markov chain represented by equation 1 is stationary. A Markov chain is stationary if for all classes i and j,

$$P[\, X_t = j \mid X_{t-1} = i] = P[\, X_{t+k} = j \mid X_{t+k-1} = i] = p_{ij} \tag{3}$$

for all k. Equation 3 means that a bank=s transition probability is constant across time. Clearly this is likely to be an overly restrictive assumption when applied to changes in the size distribution of the banking industry. Because this assumption is likely to be overly restrictive, we test for stationary transition probabilities later in the paper. The test results will often fail to accept the assumption and consequently point to nine different episodes of consolidation. For ease of explanation, however, we assume equation 3 holds in this section.

Assuming stationarity then allows one to construct an estimate of each p_{ij}, i.e., the probability of a bank in size class i moving to size class j next period. If the process is stationary, then a reasonable estimate of p_{ij} is the average ratio of banks in class i that moved to class j in each period to the total number of banks in class i at the start of the respective period. Thus,

$$p_{ij} = \frac{1}{T-1} \sum_{t=1}^{T-1} \frac{N_{ij}^{t}}{N_{i}^{t}}\,, \tag{4}$$

where N_{ij} is the number of banks moving during one period from class i to class j and N_i is the total number of banks that were in class i in period t.

If the transition matrix, M, is stationary, then repeatedly applying that matrix to the original size distribution will give an accurate estimate of the size distribution for any number of future periods. For instance, assuming M is stationary, the two-step-ahead distribution evolves as

$$F_{t+2} = M' \, F_{t+1} = M' \, M' \, F_t \,. \tag{5}$$

In general, when M is stationary the k-step-ahead distribution is simply

$$F_{t+k} = [M']^k F_t . \tag{6}$$

In a Markov study of banking, even if M is stationary, the entry and exit of banks will also affect the size distribution, F. In order to accommodate the entry of new banks, an accurate projection of the future size distribution requires including an estimate of the number of *de novo* banks in each size class in each period.[9] This estimation is accomplished by modifying equation 1 as follows:

$$F_{t+1} = B_t + M' F_t , \tag{7}$$

where B is a vector representing the estimated number of *de novo* banks entering each size class in period t and M and F are as before. Because most *de novo* banks are small, adding them to the pool will slow the attrition rate from the left side of the distribution.

4. Data Used in the Study

This paper applies the Markov model to changes in a banking organization's size, where real assets determine an institution's size.[10] We use assets because they are a common measure of size, but other measures, such as deposits, are also feasible and would likely have no influence on the results. Using assets rather than deposits to measure size does avoid any problems that might arise from larger banks shifting away from deposits to other liabilities as they grow.

To construct the transition matrix, we partition the size distribution into seven size classes. The first size interval, class one, captures the portion of the distribution typically associated with small community banks, i.e., institutions with less than $100 million in assets.

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[9] We discuss accommodating banks exiting the industry in the following section.
[10] Real assets are total assets divided by the GDP deflator (1996=100).

We construct the next five size classes so that the transition matrix can capture the probability of a bank tripling in size regardless of its original size. Thus, if a $50 million institution moves up one size class if it triples in size to $150 million, then we also want a $150 million bank or a $1 billion bank to move up one size class if it triples in size. We accomplish this by making the top of each interval equal to three times the top of the previous interval. The final interval, size class seven, captures large institutions in the right tail of the distribution, i.e., those with greater than $24.3 billion in assets.[11] A note to table 1 shows the actual size intervals for the seven assets classes.

With the seven size classes used in this study, the transition matrix would have seven rows and seven columns, but an additional row and column are necessary to capture banks exiting the sample.[12] Because banks do not reenter the sample after exiting, the row associated with merging/failing banks always has a one in the exit column and zeros elsewhere. Consequently, we do not show this row in our results.

While some banks are leaving the sample, de novo banks are entering the sample. Between 1966 and 1999 new charters added nearly 200 new commercial banks each year. During this period the number of new charters ranged from a low of 49 in 1994 to a high of 391 in 1984. There were 232 new charters in 1999. The transition matrix includes new banking

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[11] Other interval sizes, such as intervals double or quadruple the previous interval, would also be appropriate and would not be likely to change the nature of the results. Increasing the size of the interval would tend to increase the probability that an institution would remain in the same size class. Decreasing the size of the interval would decrease the probability that an institution would remain in the same size class.

[12] Exits include both mergers and failures. These are not counted separately because of ambiguities that arise when trying to distinguish failures from some mergers. Furthermore, the current focus is on institutions exiting the banking industry regardless of whether the departure is the result of a merger or a failure.

organizations in their appropriate size class when they have two consecutive years of data. Institutions need two consecutive years of data in order to register in the transition matrix.

Bank structure and asset data used in the study comes from the December Consolidated Reports of Condition and Income (call reports) for commercial and cooperative banks. The period under study runs from December 1960 through December 2000. The study excludes special-purpose banks, credit card banks, credit unions, and savings and loan associations.[13] The study consolidates data at the level of the highest holding company. If a bank holding company owns more than 4.9 percent of a bank and does not qualify as a passive investor, then the balance sheets of all such banks are combined into a single balance sheet representing the bank holding company.[14] This also applies to commercial banks with new charters that are part of an existing holding company.

Throughout the study we define banks at the level of the highest holding company. Doing so allows us to capture the size of an organization regardless of how each organization's structure may have evolved because of earlier restrictions on branching. We wish to treat alike a bank holding company that owns ten banks in a state that places no restrictions on bank holding companies but prohibits branching and a bank that owns ten branches in a state that permits branching. This definition allows the transition matrix to capture only mergers of unrelated institutions as opposed to mergers within a holding company consolidating its subsidiaries.

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[13] Commercial banks that convert to special-purpose banks exit the sample at the conversion date.

[14] Holding companies may own between 5 percent and 25 percent equity in a bank and still qualify as a passive investor. If a holding company qualifies as a passive investor, then the bank is treated as an independent bank.

5. An Application of Markov Chains

To study consolidation using the Markov chain model, we first partition the size distribution into our seven discrete size classes. These size partitions indicate how many institutions are in each size class during the study. (The vast majority of banking organizations throughout the sample period are small institutions with less than $300 million in assets.) Table 1 shows the number of banking organizations by asset size for 1960, 1980, and 2000. In 1960, more than 90 percent of banks had less than $100 million in real assets. By the end of the year 2000, the number of institutions of this size accounted for only 60 percent of the distribution, but including institutions with up to $300 million in assets again accounts for almost 90 percent of the distribution.

The shifting size distribution evident in table 1 reflects one way in which technological and legislative changes have affected banks. The large number of small banks in 1960 indicates the success of branching and interstate banking restrictions designed to keep banks small. Between 1960 and 1980, deregulation and technological changes began to lower barriers to expansion and set the stage for consolidation. Between 1980 and the end of 2000, consolidation had substantially reduced the total number of banks and shifted the size distribution to the right as surviving banks expanded according to their new opportunities.

While table 1 may summarize the dramatic story of consolidation in the banking industry, the transition matrix (table 2) illuminates the movements taking place within the consolidation process. The transition matrix tracks banks each year as they either change size classes, remain in the same size class, or exit from the industry. For example, table 2 shows the transition matrix reflecting movements among size classes for one year, from December 1999 to December 2000.

Each row indicates the size class of the institution in 1999 (year T) and each column indicates the institution's size class in 2000 (year T+1). For example, reading across the row for size class two tells us the following: Of the 1,777 banking organizations in class two at the end of 1999, 1,572 institutions were still of size two at the end of 2000, 24 had decreased to size one, 82 had increased to size class three, and 99 had exited the industry.

The Markov model uses the frequency of these changes each year to estimate a transition probability for each element of the transition matrix. Continuing with the above example, the sum of each row is just the number of institutions in that size class at the start of the period (year T). The transition probability is equal to the number of banks in each cell of the transition matrix divided by the sum of its respective row. Table 3 shows the transition probabilities corresponding to the transition frequencies of table 2. For instance, the 1,572 of 1,777 banking organizations that remained in size class two between 1999 and 2000 yield a transition probability of .885, and the 99 institutions that exited the industry yield a transition probability of .056. In other words, a bank with assets between $100 million and $300 million in 1999 had roughly an 89 percent chance of being in the same size class in 2000 and approximately a 6 percent chance of exiting the industry.

The diagonal elements in each matrix are the probabilities associated with remaining in the same size class next period. Probabilities near one along the diagonal indicate high persistence in the distribution. If the distribution doesn't change, then the matrix of transition probabilities would be an identity matrix with ones along the diagonal and zeros elsewhere.

Testing for Stationarity of Transition Probabilities

In the Markov model, the estimate of multi-period transition probabilities is just an average of the transition probabilities from each period. If the transition matrix were stationary, then the 1960-2000 transition matrix would be the average of the year-to-year transition matrices covering those 40 years. Clearly, with all the changes in the banking industry, an assumption of stationary transition probabilities seems rather restrictive. Fortunately, we can test the stationarity assumption.

Anderson (1954) and Anderson and Goodman (1957) show us that we can use a likelihood ratio criterion to test whether a multiple period transition matrix is stationary. The likelihood ratio criterion (λ) is as follows:

$$\lambda = \prod_t \prod_i \prod_j \left(\frac{\hat{p}_{ij}}{\hat{p}_{ij;t}}\right)^{N_{ij}(t)}, \tag{8}$$

where p_{ij} (the average transition probability over the test period) is given by equation 4 and $p_{ij;t}$ (the single period transition probability) is given by

$$\hat{p}_{ij;t} = \frac{N_{ij}(t)}{N_i(t-1)}. \tag{9}$$

As an example of equation 9, the elements of the matrix in table 3 represent $p_{ij;2000}$, or the transition probabilities between 1999 and 2000.

Anderson and Goodman (1957) show that (-2)log λ converges to a chi-squared distribution with (T-1)[m (m-1)] degrees of freedom for large n, where m is the dimension of the transition matrix and T is the number of periods under consideration. In this study, m is equal to eight: the seven size classes plus the exit class. The value of T varies across tests.

Anderson (1954) shows that we may use this test sequentially to determine whether the same matrix applies to successive time periods. For this study, the first test determines whether the transition matrix composed of the average transition probabilities for 1960-61 and 1961-62 is statistically equivalent to the matrix for each year separately. The null hypothesis is that the average transition matrix sufficiently describes both periods, i.e., that the matrix is stationary and both Markov properties hold. A small value for λ accepts the null hypothesis. If the test fails to reject the null hypothesis at the five percent level, then the process continues by adding one more year and repeating the test. The procedure repeats until the test rejects the null hypothesis at the five-percent level. Together, the years that pass the sequential tests form a stationary episode of consolidation.

The search for the next stationary episode begins once the test rejects the null hypothesis for the previous episode. A new sequence begins using the ending period of the last test as the starting period of the next set of tests. For instance, the first set of tests shown in table 4 accepts the null hypothesis of a stationary transition matrix from 1960 through 1971, but rejects when the test includes the 1971-72 transition matrix. Thus, the next set of tests begins with a comparison of the 1971-72 and 1972-73 transition matrices.

Results from these sequential tests point to nine distinct stationary episodes that describe banking organization transitions between 1960 and 2000. Table 4 presents a summary of the test results. The table shows the first two sequential tests comparing 1960-61 to 1961-62 and then adding 1962-63 after the first test fails to reject the null hypothesis. For brevity, after these first two sequential tests, table 4 then shows only test results for each stationary episode followed by the results showing the subsequent rejection after adding one more year. The years for each stationary consolidation episode are in bold and the duration of each episode appears in the last column of the table.

The stationary episodes and their corresponding transition probabilities provide a detailed and informative picture of the consolidation process. The first stationary episode continued for 11 years, from 1960 through 1971, and may be longer considering our sample period begins in 1960. This 11-year episode is by far the longest during the 40 years studied. In addition to being the longest stationary episode, this highly persistent matrix tells a story of little movement in the size distribution of banks between 1960 and 1971.[15] Table 5 shows the remarkably persistent transition matrix for this episode. This matrix describes a period of stability in the banking industry before economic upheaval in the 1970s began to rearrange the banking landscape.

The diagonal elements of each transition matrix indicate the degree of persistence, i.e., the probability of remaining in the same size class. The remarkably high level of persistence during the 1960s is evident in the diagonal elements shown in table 5. During this episode banks had at least a 93 percent chance of staying in the same size class and at most a 1.3 percent chance of exiting the industry. These high degrees of persistence and low probabilities of exit have not recurred in the banking industry since.

Subsequent changes in the transition matrices reveal when changes began to occur in the banking industry. Although the total number of banking organizations continued to grow during the 1970s, decreasing persistence and an increasing probability of leaving the industry

[15] Tests making 1960 the start of a period use individual banks rather than banking organizations because of changes in holding company identification during the period. Duplicate tests using banking organizations reject the null hypothesis in 1970, the year the new identification begins.

characterize the changes that began in the early 1970s. Table 6 shows the principal transition probabilities (staying in the same class, moving up or down one class, or exiting) for each of the nine stationary episodes from 1960-2000.

A brief two-year episode of generally increasing prosperity for banks immediately followed the long stable episode of the 1960s. Although persistence fell slightly for five of the size classes during this stationary period from 1971-73, the probability of exiting also fell or stayed the same for all seven size classes. The offsetting increase came from the greater probability that banks would increase a size class. Thus, during this period banks were more likely to grow and even less likely to leave the industry than they had been during the 1960s. The recession that began in November of 1973 likely contributed to the end of this episode of prosperity.[16]

The next episode, just one year, is the shortest episode in the sample and the first to show a sharp rise in exit probabilities. During this episode (from 1973 to 1974), the probability of leaving the industry increased suddenly for all but the largest size classes. For the six size classes below the largest one, exit probabilities that had been between 0 percent and 1 percent jumped to between 3 percent and 16 percent. As table 6 shows, the probability of dropping a size class also increased greatly while there were corresponding decreases in the probabilities of increasing a size class or remaining in the same size class. While these dramatic changes only lasted one year, exit probabilities never returned to the low levels of the 1960s and early 1970s.

After the 1973-74 upheaval, relative calm returned to banking between 1974 and 1979. From 1974 through 1979 the probability of leaving the industry fell from 1973-74 levels, but

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[16] Recession dates are from the National Bureau of Economic Research, US Business Cycle Expansions

remained well above the pre-1973 levels for the five smallest size categories. The probability of decreasing a size class also declined from the prior episode for all but the largest banks, but these probabilities also remained well above their pre-1973 levels. The probability of increasing a size class rose from 1973-74 levels, but organizations in the four smallest categories were more likely to exit than they were to increase a size class. Banking organizations with less than $2.7 billion dollars had between a 3 percent and a 4 percent chance of leaving the industry. For larger institutions, the probability of exit fell progressively from 2 percent to 0 percent as the institution's size increased. These transition probabilities remained stationary until recession once again upset the status quo.

Recessions in 1980 and 1981 likely led to changes in the transition matrix for the 1979-81 episode that were similar to the changes that occurred during the recession of 1973-1974. Between 1979 and 1981 persistence and the probability of increasing a size class fell while the probability of exit and decreasing a size class rose. This was particularly true for institutions with less than $2.7 billion; for them the probability of exiting the industry rose to between 6 percent and 10 percent from the 3 percent and 4 percent levels between 1974 and 1979. Larger institutions also had a higher probability of exit than in the 1974-79 period — between 2 percent and 4 percent. As turbulent as these two years may have been for banks, it was just the beginning, especially for smaller banks.

Although recession ended in November 1982, the transition matrix did not respond to the return of economic growth the way it had in 1974. After 1981, deregulation emerges as a likely determinant of changes in the transition matrices as the banking industry begins to consolidate.

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and Contractions, www.nber.org/cycles.html.

Whereas exit probabilities had fallen for all size classes after 1973-74, after the 1979-81 episode they rose above the already high recession levels for all but the largest banks. Indeed, for institutions with less than $2.7 billion in assets, the 1981-86 period was to be the most volatile era. During this period, the likelihood that these institutions would leave the industry through merger or failure rose to the highest levels of the 40 years under consideration — to between 10 percent and 16 percent. The probability of exiting also increased for institutions with between $2.7 billion and $24.3 billion in assets, but to just 6 percent from around 3 percent during 1979-81. For institutions with assets greater than $24.3 billion, exit probabilities during the 1981-1986 episode were lower than they were during the 1979-81 episode.

After 1986, the rapid rate of consolidation that had affected small banks for five years moved on to larger banks. During the next consolidation episode, between 1986 and 1990, exit probabilities fell to between 7 percent and 8 percent for banks in the four smallest size categories. At the same time, exit probabilities rose for the three largest size groups. Nonetheless, these larger institutions remained less likely to exit the industry than institutions in the smaller size groups.

This long-running characteristic of the transition matrices, i.e., that smaller banks are more likely to exit the industry than larger banks, began to change after 1990. During the 1990-94 episode, exit probabilities for the three smallest size classes continued to fall and reached their lowest levels since the end of the 1970s. Although exit probabilities also fell for the two largest size classes, the likelihood of departure rose for organizations with between $900 million and $8.1 billion in assets. In particular, the 10 percent exit probability for institutions with assets between $2.7 billion and $8.1 billion was the highest for the 40-year study period. This also represented the first time since the brief 1973-74 episode that institutions with billions of dollars in assets were more likely to leave the industry than institutions with assets only in the millions.

The size of the institutions most likely to exit the industry again changed at the start of our current consolidation episode, which began in 1994 and continued through 2000. Whereas smaller institutions had been the most likely to exit the industry throughout most of the study period, the largest institutions became the most likely to depart after 1994. In the 1994-2000 episode, organizations in the two largest size classes had the highest exit probabilities (nearly 10 percent), while institutions in the two smallest size classes had the lowest exit probabilities (between 7 percent and 8 percent). As the number of mergers increased after 1994, institutions in all size classes except class five had higher exit probabilities compared to the 1990-94 period. For institutions in the first four size classes these probabilities were still well below the peak levels reached between 1981 and 1986. For banks in the largest size class, however, the nearly 10 percent exit probability reached its highest level of the sample period.

Another interesting characteristic of the 1994-2000 episode is that the probability of decreasing a size class fell sharply across all size classes. The probabilities of shrinking a size class, between 0 percent and 1 percent, were at levels comparable to the pre-recession episode of prosperity between 1971 and 1973. Also similar to the 1971-73 episode, the probability of increasing a size class increased substantially across all size groups.

The results of the stationarity tests allow us to draw important distinctions between different periods within the era of consolidation. High persistence and low probability of exit in the 1960s and early 1970s contrasts sharply with the transition matrices of the 1980s and 1990s. Persistence within all size class fell between 1960 and 2000. While the lowest persistence probability in the 1960s was 93 percent, the highest persistence probability in the 1994-2000 matrix was 90 percent and the lowest was 81 percent.

As persistence dropped during the past 40 years, the probability of exit across all size classes rose. For instance, the probability of exit for the smallest size class increased from 1 percent during the 1960s to approximately 7 percent during the 1990s. In the 1960s, institutions with between $100 million and $300 million in assets had the highest exit probability of any class — a mere 1.3 percent. In the 1994-2000 episode, the lowest exit probability was 7.1 percent (institutions with less than $100 million in assets) and the highest was 9.8 percent (institutions with assets greater than $24.3 billion). Also indicative of how much has changed in the past 40 years, the probability of exiting increases with bank size during the 1994-2000 episode, whereas roughly the opposite was true in the 1960s.

6. Projections of the Future Structure of Banking

In addition to providing a valuable decomposition of the consolidation era, the Markov transition matrix can provide potentially useful projections of future size distributions. Although the relatively short duration of consolidation episodes since 1971 discourage making long-term projections based on them, stationary episodes of short duration suggest that short-term projections may be made with a modest degree of confidence. Bankers, bank regulators, and legislators may find these projections useful for supervisory planning purposes and for monitoring changes in industry conditions against the backdrop of expectations these projections provide.

Earlier studies of consolidation by Hannan and Rhoades (1992), Robertson (1995), and Berger, Kashyap, and Scalise (1995) also made projections of the size distribution of the banking industry. In these earlier studies, the Hannan and Rhoades and Berger, Kashyap, and Scalise studies extrapolate future consolidation from past changes in geographic restrictions. Hannan and Rhoades predict that 5,500 banking organizations will remain in the year 2010. Berger, Kashyap, and Scalise predict that 4,125 banking organizations will remain in the year 2004. Robertson (1995), using a Markov approach with stationarity assumed, predicted that 5,145 banking organizations would remain in the year 2005.[17]

We project the number of banks in each size class through the year 2007 using the transition matrix from the 1994-2000 episode. In order to account for new entrants, we add 131 new banks to size class one for each year through 2007. That number of new banks is the annual average of new independent charters between 1990 and 1999.[18] Table 7 shows the projected size distribution starting from the year-end 2000 distribution. We project that the total number of banking organizations will continue to decline from 6,750 in 2000 to 4,567 in 2007. This represents a decrease of nearly 2,200 banks or roughly one-third of the 2000 total. The number of banks exiting the industry will gradually diminish from almost 400 in 2001 to less than 250 in

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[17] Gup, Lau, Mattheiss, and Walter (1991) use a Markov approach to project combined asset size and return-on-asset performance.

[18] There was an average of 131 new charters each year between 1990 and 1999. Because most new entrants have under $100 million in assets, we add new entries to size class one at the end of each year of the projection. Clearly, eliminating new entrants would greatly reduce the number of banks in the smallest size class and the total number of institutions. However, it is highly unlikely that there will be no new charters or conversions in any given year. Even at the end of the banking crisis in 1994 there were 49 new charters and 12 conversions. There was also an annual average of 28 charter conversions during 1990-99, but we don't add these in order to account for new entrants that might be part of an existing bank holding company. For a sample of de novo banks from 1980-85, DeYoung (2000) found that 14 percent were part of a multibank holding company.

2007. This gradual decrease in the number of exits is the result of applying a constant probability of exit from the 1994-2000 transition matrix to a shrinking pool of banks.[19]

Not surprisingly, the projections suggest that smaller banking organizations will continue to fall steadily in number and will continue to account for the vast majority of departing banks. As table 7 shows, the projection suggests that the number of banking organizations with less than $100 million in real assets will fall from 4,041 at the end of 2000 to just 2,497 by the end of 2007, nearly a 40 percent decline over those seven years. These projections also suggest a considerable drop in the number of institutions in size classes two and three, which will decrease 30 percent and 13 percent, respectively.

The same transition matrix suggests a slightly different future for mid-size banks, i.e., those with assets between $900 million and $8.1 billion. We project the number of organizations in size class four to fall a mere 2 percent and the number of institutions in category five to increase approximately 8 percent. Looking back at the transition matrix behind these projections, we see that these modest changes are not the result of high persistence probabilities, which actually rank among the lowest. Rather the low rate of attrition in class four, for instance, occurs because roughly the same number of institutions enter from the larger pool in class three as leave class four.

Changes in the two largest groups in essence provide us with estimates of how many large bank mergers regulators can expect each year given the current transition matrix. While

[19] Most of these exits will likely occur in states that once restricted intrastate branching. Of the 2,469 institutions that exited between 1994 and 1998, 56 percent were from states that had unit branching restrictions in the 1960s and 30 percent came from states that limited either the number or location of branches. These numbers suggest that much of the consolidation story represents a continuing reaction to geographic deregulation.

the number of institutions in classes six and seven will fall 22 percent and 9 percent, respectively, this attrition is due to three banks exiting each of these categories each year. Assuming that these exits are mergers and not failures, our projections suggest approximately three mergers in each of the two largest size categories each year through 2007.

Although a new consolidation episode may begin at any time, only an unprecedented and drastic change in transition probabilities would alter the basic result that the banking industry will continue to consist of thousands of banking organizations. It is also apparent that most of these institutions will continue to be small. According to these projections, even the smallest institutions, those with less than $100 million in assets, will continue to make up more than half of the industry. Banking organizations with assets of $900 million or less will continue to account for more than 90 percent of the bank population through 2007. These projections suggest that even though banking will remain highly competitive and consolidation will likely continue, thousands of community banks will survive.

These projections fall between the earlier projections of Hannan and Rhoades and Berger, Kashyap, and Scalise. Our projection of 4,567 banking organizations in 2007 is already well below Hannan and Rhoades' (1992) projection of 5,500 organizations in 2010. On the other hand, our projection of 5,359 banks in 2004 is well above Berger, Kashyap, and Scalise's (1995) projection of 4,125 institutions in 2004. Our projection of 5,074 institutions in 2005 falls closest to Robertson's (1995) projection of 5,145 institutions in the same year.

7. Conclusion

Consolidation has been a dominant part of the banking landscape for decades. In this paper, a Markov chain model and accompanying likelihood ratio tests allow us to identify nine different episodes within the era of consolidation.[20] Identifying these episodes is important because it allows us to see in greater detail how consolidation has affected banks of different sizes in different ways at different times. Comparing the nine episodes shows that since the 1980s the rate of attrition has slowed for smaller banks and accelerated for larger banks.

Consolidation's principal characteristic is a decline in the number of institutions in the industry. If we think of consolidation as a period when an institution faces a high probability of leaving the industry, then the early 1980s were the most significant years of consolidation for smaller banks. In the early 1980s, banks with less than $2.7 billion in assets had between an 11 percent and 16 percent chance of exiting the industry, well above the 1 percent probability in the 1960s. Between 1994 and 2000 the probability of exiting for the smaller banks had fallen to between 7 percent and 9 percent.

While consolidation means departure for some, for those that remain it also suggests opportunities for growth. Looking at consolidation from this perspective, institutions in the two smallest size categories were more likely to increase a size class between 1994 and 2000 than at any other time in the past 40 years. Midsize institutions (size classes 3, 4, and 5) enjoyed their golden era of growth opportunity during the early 1980s, the same period when smaller institutions were most likely to exit. For large institutions with assets between $8.1 billion and

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[20] Another advantage of the Markov approach, although not pursued in this study, is that it has the flexibility to look at changes in smaller geographic markets using relatively small samples. For instance, the Markov model can provide transition matrix estimates and projections for regional, state, or even

$24.3 billion, the 1994-2000 period was important from both perspectives. During this period, these institutions were not only more likely to increase a size class than at any time since the early 1970s, they were also more likely to exit the industry.

Over the past 40 years, the probability of leaving the industry for the largest banks grew from 0 percent during the first 20 years under study to the highest of any of the size classes during the most recent consolidation episode. In the 1994-2000 period, larger banks were more likely to exit the industry than smaller banks. Indeed, the smallest banks had the lowest probabilities of exiting the industry. Nonetheless, even though the attrition rate among small banks has slowed since the early 1980s, continuing consolidation and a large pool of small banks still means that hundreds of small banks will exit the industry each year for many years to come.

In addition to identifying different stationary periods of consolidation, the Markov model provides us with a simple tool for making short-range projections of the banking industry's size structure. While our test results tell us that the transition matrices used to make these projections change over time, transition probabilities from the most recent consolidation episode provide a plausible short-range structural forecast of the banking industry. These forecasts should be especially reliable compared with forecasts that do not distinguish between consolidation episodes. Our projections into the early part of the 21st century suggest that small banks will continue to account for most of the institutions in the banking industry. More than 90 percent of the estimated 4,500 banking organizations in 2007 will be institutions with less than $900 million in assets.

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large metropolitan markets.

These transition matrix estimates emerge against a background of continuing change in the banking industry. Laws governing competitive barriers continue to change as does the technology used by banks and their competitors. While it is certainly possible that some change in the future might threaten the existence of small banks, evidence from transition matrices suggest that such a change has yet to occur. Although nationwide branching creates a nearly national banking market, the idiosyncrasies in local markets that preserved small banks through the last 40 years will likely preserve many of them through the years ahead.[21]

[21] For more on factors transforming the banking industry, see Boyd and Graham (1991), Berger, Kashyap, and Scalise (1995), Nolle (1995), Berger, Demsetz, and Strahan (1999), and Shull and White (2000).

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Table 1. Size Distribution of Banking Organizations: 1960, 1980, and 2000

Real Assets	Size Class	Number of Banking Organizations			Percent of Total		
		1960	1980	2000	1960	1980	2000
Under $100 Mil.	1	11699	10096	4041	91.4%	81.5%	59.9%
$100 Mil. to $300 Mil.	2	719	1554	1833	5.6%	12.5%	27.2%
$300 Mil. to $900 Mil.	3	235	409	572	1.8%	3.3%	8.5%
$900 Mil. to $2.7 Bil.	4	103	185	175	0.8%	1.5%	2.6%
$2.7 Bil. to $8.1 Bil.	5	31	106	59	0.2%	0.9%	0.9%
$8.1 Bil. to $24.3 Bil.	6	15	28	36	0.1%	0.2%	0.5%
Over $24.3 Bil.	7	3	13	34	0.0%	0.1%	0.5%
Total		12805	12391	6750			

Real Assets from implicit GDP deflator, 1996=100
Class 1 = Real Assets Under $100 million
Class 2 = Real Assets Between $100 million and $300 million
Class 3 = Real Assets Between $300 million and $900 million
Class 4 = Real Assets Between $900 million and $2.7 billion
Class 5 = Real Assets Between $2.7 billion and $8.1 billion
Class 6 = Real Assets Between $8.1 billion and $24.3 billion
Class 7 = Real Assets $24.3 billion and over

Table 2. Banking Organization Transition Matrix, 1999-2000

1999 Size Class	2000 Size Class								1999 Total
	1	2	3	4	5	6	7	Exit	
1	3753	209	1	0	0	0	0	235	4198
2	24	1572	82	0	0	0	0	99	1777
3	1	6	475	24	0	0	0	43	549
4	0	1	1	144	9	1	0	10	166
5	0	0	0	1	46	7	0	9	63
6	0	0	0	0	1	28	1	1	31
7	0	0	0	0	0	0	33	1	34

Class 1 = Real Assets Under $100 million
Class 2 = Real Assets Between $100 million and $300 million
Class 3 = Real Assets Between $300 million and $900 million
Class 4 = Real Assets Between $900 million and $2.7 billion
Class 5 = Real Assets Between $2.7 billion and $8.1 billion
Class 6 = Real Assets Between $8.1 billion and $24.3 billion
Class 7 = Real Assets $24.3 billion and over

Table 3. Banking Organization Transition Probabilities, 1999-2000

1999 Size Class	2000 Size Class							
	1	2	3	4	5	6	7	Exit
1	.894	.050	.000	0	0	0	0	.056
2	.014	.885	.046	0	0	0	0	.056
3	.002	.011	.865	.044	0	0	0	.078
4	0	.006	.006	.867	.054	.006	0	.060
5	0	0	0	.016	.730	.111	0	.143
6	0	0	0	0	.032	.903	.032	.032
7	0	0	0	0	0	0	.971	.029
Exit	0	0	0	0	0	0	0	1

Class 1 = Real Assets Under $100 million
Class 2 = Real Assets Between $100 million and $300 million
Class 3 = Real Assets Between $300 million and $900 million
Class 4 = Real Assets Between $900 million and $2.7 billion
Class 5 = Real Assets Between $2.7 billion and $8.1 billion
Class 6 = Real Assets Between $8.1 billion and $24.3 billion
Class 7 = Real Assets $24.3 billion and over

Table 4. Likelihood Ratio Test Results

Test Period	Chi-Square Test Statistic	Degrees of Freedom	Five Percent Critical Value	Test Result	Episode Duration
1960-1962	26.10	56	74.47	Accept**	
1960-1963	39.06	112	137.70	Accept**	
1960-1971	532.04	560	616.16	Accept**	11 years
1960-1972	679.44	616	674.85	Reject*	
1971-1973	70.48	56	74.47	Accept*	2 years
1971-1974	429.19	112	137.70	Reject**	
1973-1975	83.56	56	74.47	Reject**	1 year
1974-1979	222.64	224	259.91	Accept**	5 years
1974-1980	749.07	280	320.03	Reject**	
1979-1981	44.61	56	74.47	Accept**	2 years
1979-1982	304.97	112	137.70	Reject**	
1981-1986	234.46	224	259.91	Accept**	5 years
1981-1987	371.88	280	320.03	Reject**	
1986-1990	156.84	168	199.24	Accept**	4 years
1986-1991	262.58	224	259.91	Reject*	
1990-1994	180.65	168	199.24	Accept**	4 years
1990-1995	307.65	224	259.91	Reject**	
1994-2000	227.34	280	320.03	Accept**	6 years

Accept*: Accept at 5 percent level of significance
Accept**: Accept at 10 percent or 5 percent levels of significance
Reject*: Reject at 5 percent level of significance
Reject**: Reject at 1 percent or 5 percent levels of significance

Table 5. Bank Transition Probabilities, 1960-71

Size Class in T	Size Class in (T+1)							
	1	2	3	4	5	6	7	Exit
1	.978	.012	.000	0	.000	0	0	.010
2	.011	.944	.032	.000	0	0	0	.013
3	0	.010	.946	.036	0	0	0	.008
4	0	0	.010	.945	.037	0	0	.009
5	0	0	0	.009	.969	.016	0	.007
6	0	0	0	0	.014	.931	.049	.007
7	0	0	0	0	0	.047	.953	0
Exit	0	0	0	0	0	0	0	1

Class 1 = Real Assets Under $100 million
Class 2 = Real Assets Between $100 million and $300 million
Class 3 = Real Assets Between $300 million and $900 million
Class 4 = Real Assets Between $900 million and $2.7 billion
Class 5 = Real Assets Between $2.7 billion and $8.1 billion
Class 6 = Real Assets Between $8.1 billion and $24.3 billion
Class 7 = Real Assets $24.3 billion and over

Table 6. Transition Probabilities for Stationary Episodes

Size Class in T	Size Class T+1	Stationary Episode								
		60-71	71-73	73-74	74-79	79-81	81-86	86-90	90-94	94-00
1	1	.978	.973	.960	.960	.916	.870	.901	.909	.886
	2	.012	.019	.005	.011	.008	.022	.019	.023	.043
	Exit	.010	.008	.034	.029	.076	.108	.080	.068	.071
2	1	.011	.012	.058	.022	.036	.023	.032	.029	.014
	2	.944	.947	.874	.924	.849	.798	.863	.883	.857
	3	.032	.036	.014	.018	.016	.035	.024	.026	.046
	Exit	.013	.006	.053	.036	.097	.142	.080	.061	.083
3	2	.010	.015	.057	.027	.050	.028	.038	.033	.014
	3	.946	.921	.874	.903	.825	.753	.855	.867	.843
	4	.036	.055	.014	.026	.029	.055	.030	.027	.053
	Exit	.008	.008	.055	.037	.096	.163	.073	.072	.089
4	3	.010	.013	.087	.035	.046	.016	.029	.032	.011
	4	.945	.930	.847	.902	.873	.766	.852	.834	.829
	5	.037	.052	.011	.029	.011	.072	.039	.045	.066
	Exit	.009	.005	.055	.033	.067	.146	.076	.087	.088

Note: The probability of rising or falling more than one size class after a year is most often 0 percent and in only one instance reached 1 percent. Thus, table 6 does not include these probabilities.

Table 6 -continued. Transition Probabilities for Stationary Episodes

Size Class in T	Size Class T+1	Stationary Episode								
		60-71	71-73	73-74	74-79	79-81	81-86	86-90	90-94	94-00
5	4	.009	.020	.061	.020	.019	.009	.028	.037	.011
	5	.969	.927	.837	.935	.952	.835	.852	.801	.821
	6	.016	.046	.020	.026	.005	.094	.047	.061	.079
	Exit	.007	.007	.071	.018	.024	.061	.072	.101	.087
6	5	.014	0	.280	.009	.101	.022	.044	.054	.005
	6	.931	.875	.560	.973	.864	.832	.818	.831	.814
	7	.049	.125	0	.009	0	.086	.066	.048	.088
	Exit	.007	0	.160	.009	.034	.059	.072	.060	.093
7	6	.047	0	0	.016	0	.023	.041	.033	0
	7	.953	1.00	1	.984	.962	.965	.901	.918	.897
	Exit	0	0	0	0	.038	.012	.058	.049	.098

Class 1 = Real Assets Under $100 million
Class 2 = Real Assets Between $100 million and $300 million
Class 3 = Real Assets Between $300 million and $900 million
Class 4 = Real Assets Between $900 million and $2.7 billion
Class 5 = Real Assets Between $2.7 billion and $8.1 billion
Class 6 = Real Assets Between $8.1 billion and $24.3 billion
Class 7 = Real Assets $24.3 billion and over

Table 7. Projected Size Distribution of Banking Organizations, 2001-2007

Projection Using 1994-2000 Transition Matrix
With 131 New Charters Added to Size Class One Each Year

Size Class	Actual 2000	Projection to Year						
		2001	2002	2003	2004	2005	2006	2007
1	4041	3737	3466	3225	3011	2820	2649	2497
2	1833	1751	1668	1585	1504	1425	1349	1276
3	572	570	564	555	544	530	515	499
4	175	176	176	176	176	175	174	172
5	59	60	61	62	62	63	63	63
6	36	34	32	31	30	29	29	28
7	34	34	34	33	33	32	32	31
Total	6750	6361	6001	5667	5359	5074	4810	4567
Net Exit	-	389	360	334	308	285	264	243

Class 1 = Real Assets Under $100 million
Class 2 = Real Assets Between $100 million and $300 million
Class 3 = Real Assets Between $300 million and $900 million
Class 4 = Real Assets Between $900 million and $2.7 billion
Class 5 = Real Assets Between $2.7 billion and $8.1 billion
Class 6 = Real Assets Between $8.1 billion and $24.3 billion
Class 7 = Real Assets $24.3 billion and over