Effects of Bank Consolidation on the Bank Insurance Fund

Robert Oshinsky
Financial Economist
Division of Research and Statistics
Federal Deposit Insurance Corporation
550 17th Street, N.W.
Washington, D.C. 20429
Phone: 202-898-3813
Fax: 202-898-7149
E-mail: roshinsky@fdic.gov

1. Introduction

Consolidation in the banking industry has increased at record levels during recent years. At year-end 1990, the 25 largest banking organizations held approximately 22 percent of industry assets; by year-end 1998, this figure had increased by more than two-thirds to approximately 54 percent.

This study examines the implications of this consolidation for the Bank Insurance Fund (BIF). The results show that, based on historical loss and failure rates, the consolidation that took place between 1990 and 1997 increased the risk of BIF insolvency by approximately 50 percent, and that megamergers that took place or were announced during the 18 months between year-end 1997 and midyear 1999 increased the risk of insolvency further. Moreover, unlike the BIF of 1990, the solvency of the BIF of today is inseparably tied to the health of the largest banking organizations.

Section 2 ("Background") of this study provides background information on trends in the industry, differences between large and small institutions, and historical loss and failure rates. Section 3 ("Simulation Model") describes the Monte Carlo model used to simulate the financial condition of the BIF. Section 4 ("Results") discusses the results, and section 5 ("Conclusion") contains some concluding remarks.

2. Background

Two studies were conducted in the 1990s predicting the probability of insolvency of the BIF, but major changes in the banking industry since the mid-1980s have raised critical issues not addressed by the authors of those studies, Sherrill Shaffer in 1991 and Kevin Sheehan in 1998. Shaffer employed a Markov process to study the probability of

insolvency of the BIF. On the basis of the FDIC's funding mechanism before the

Financial Institutions Reform, Recovery, and Enforcement Act of 1989 (FIRREA), he

found the BIF to be underfunded. Sheehan used a Markov-switching model, coupled

with more up-to-date assumptions about the FDIC's assessment rates, to project the

probability of insolvency under today's funding arrangements. He found that the BIF

would be able to weather most crises without becoming insolvent. But both Shaffer and

Sheehan implicitly assumed that future disbursements and losses would fall into a pattern

similar to that of past FDIC disbursements and losses. Given the structural changes

alluded to above, however, and particularly the consolidation initiated in 1998 when the

first U.S. megabank was formed (Bank of America, with $619 billion in banking assets),

the question of probable BIF insolvency needs to be studied anew.

In addressing consolidation, one cannot merely assume that large banks are big

replicas of small banks. Large banks differ from small banks not only in size but also in

liability structure, failure rates, and loss rates. To capture the effects of consolidation on

the BIF, one must take all of these differences into account.

2.1 Size: Consolidation within the Industry

When a bank fails, the FDIC is authorized to bill the cost of the failure to affiliate

or sister banks. Therefore, the model assumed that the failure of one institution

simultaneously caused the failure of affiliate institutions in a holding company. To proxy

the failure of all affiliate institutions at one time, the model aggregated institutions by

bank holding company. Therefore, the discussion of concentration is on the basis of bank

holding companies or banking organizations.[1]

Until 1977, the 100 largest banking organizations held approximately 51 percent

of industry assets (table 1). This level decreased to approximately 48 percent as of

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Table 1

Industry Consolidation

Percentage of Banking Assets Held by the Largest Banking Organizations

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	1977	1986	1990	1998	1998 *Pro forma*
25 largest	38.2%	27.9%	31.8%	53.9%	54.5%
100 largest[a]	51.5	48.4	54.6	72.6	72.7
All others	48.5	51.6	55.4	27.4	27.3

[a] Included in the 100 largest banking companies are the 25 largest banking companies.

year-end 1986. By year-end 1990, however, the level was 54.6 percent and rising. With

the acceleration of large-bank mergers in the early 1990s, the 100 largest banking

organizations held 72.6 percent of industry assets as of year-end 1998. After adjusting

for announced mergers as of June 30, 1999,[2] the new 100 largest banking organizations

on a *pro forma* basis will hold 72.7 percent of the industry assets. As for the 25 largest

banking organizations, throughout the 1980s they held approximately 30 percent of

industry assets, but merger activity in the 1990s rocketed this level from 31.8 percent at

year-end 1990 to 53.9 percent by year-end 1998. In addition, after adjustments are made

for the announced mergers, the 25 largest banking organizations held 54.5 percent of

industry assets on a *pro forma* basis. This level of consolidation is unprecedented in the

United States.

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[1] Throughout this paper, the terms "banking organization," "bank holding company," and "banking company" will be used interchangeably. The term "institution" refers to individual banks and not to the banking organization.

[2] These mergers include, but are not limited to, Fleet Financial Group, Inc.'s acquisition of BankBoston Corporation and Union Planters Corporation's acquisition of First Mutual Bancorp, Inc.

2.2 Liability Structure

The liability structure of banks is significantly different today than in years past. Although banks continue to rely primarily on domestic deposits for funding, the level of deposit funding has decreased significantly, falling from a high of nearly 94 percent of total assets in 1945 to a low of 66 percent of total assets in 1998. The shortfall in deposit funding has been replaced by an increased reliance on other borrowed funds, other liabilities, and capital. In addition, funding structure varies significantly with bank size. The 25 largest banking organizations depend less on domestic deposits than the smallest organizations. After the decline in deposit funding in the early 1990s, the 25 largest institutions used domestic deposits to fund 56.9 percent of domestic assets as of 1998, whereas the institutions outside of the 100 largest used domestic deposits to fund 81.0 percent of their domestic assets.

The decline in reliance on domestic deposits is a two-edged sword. On the one hand, as discussed in the next section, a reduction in a reliance on deposits may lead to lower losses if an institution fails. On the other hand, since domestic deposits make up virtually the entire BIF assessment base, a decrease in domestic deposits means that, if the BIF suffers losses, it will be more difficult for it to replenish itself than it would have been in the past.

2.3 Failure Probabilities and Loss Rates

Large and small banks also exhibit different failure probabilities and loss rates. Among BIF-member banks, large banks have historically experienced much lower loss rates, and very large banks have experienced lower failure rates. Table 2 summarizes

failure rates and table 3 summarizes loss rates, by asset-size class.

	Low	High	Average
Table 2			
Failure Rates, 1934–1997			
(Percentage of Institutions per Year)			
Top 25	0.0%	4.0%	0.1%
26–100	0.0	4.0	0.3
All others	0.0	3.5	0.3

During the first 64 years of the FDIC's existence (1934–1997), there were

2 failures of top 25 banking organizations, 12 failures of top 26–100 banking

organizations, and 1,372 failures of smaller institutions. But although the range of annual

failure rates is similar across institution sizes, the average number of failures per year for

top 25 organizations is significantly lower.

	Low	High	Simple Average	Weighted Average
Table 3				
Loss Rates, 1934–1997				
Top 50	–0.9%	10.2%	3.2%	5.3%
51–100	0.0	18.3	6.6	6.8
All others	4.8 bp	60.1	11.9	16.0

As seen in table 3, loss rates follow a similar pattern. Historical loss rates for top

100 failures (calculated as a percentage of each failed bank's assets) ranged from a small

gain to a loss of 18.3 percent, averaging 5.4 percent. The loss rates for the remaining

institutions (calculated as an annual aggregate percentage of small-bank failed assets)

ranged from a low of 4.8 basis points to a high of 60.1 percent, averaging 11.9 percent.

Economists have several explanations for the differences in failure and loss rates between

large and small institutions: large banks enjoy economies of scale, more flexibility in

funding sources, better diversification of risk, and a smaller likelihood of fraud of

sufficient size to cause failure.[3]

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[3] Another explanation may relate to systemic-risk concerns. When the LDC (less-developed-country) debt
crisis caused several large banks to become troubled in the early 1980s, regulators practiced forbearance

The model explicitly takes into account the differences between large and small institutions by incorporating the data underlying tables 2 and 3.[4] That is, it explicitly assumes that past failure and loss rates are indicative of future failures and losses. There are a number of reasons to question this assumption. Very few failures have taken place in recent years and the banking industry has changed significantly over time. As barriers to interstate banking have fallen, there has been significant geographic diversification. This has no doubt lowered the probability of failure, although the very low failure rates of the largest banking companies probably already reflect the fact that they have diversified balance sheets. The risks faced by banks have also changed as more sophisticated hedging techniques have given banks the tools to better manage risk—and to take on more risk. Increased competition from non-bank financial-service companies has also affected the risk profile of the industry.

In addition, there have been a number of legislative changes over the last decade that were designed to limit FDIC exposure. The Federal Deposit Insurance Corporation Improvement Act of 1991 (FDICIA) introduced prompt corrective action (PCA). PCA requires closure of a bank—with certain exceptions—90 days after its capital ratio falls below 2 percent. In theory, this should lead to lower losses, although in practice by the time a bank falls below 2 percent capital additional losses are often already imbedded in its balance sheet. Moreover, PCA may lead to more bank closings than would have otherwise been the case. A study of bank closings between 1980 and 1992 found that,

rather than allowing multiple large banks to fail. Forbearance has been used to assist smaller banks, as well.

[4] See section 3 below and the Appendix for details.

had PCA been in effect during that period, 143 banks that did not fail might have been closed.[5]

FDICIA also introduced the least-cost test, and the Omnibus Budget Reconciliation Act of 1993 (OBRA) introduced national depositor preference. Before these acts, the FDIC was obliged only to resolution strategies that were less costly than a payoff and liquidation. This resulted in all depositors and general creditors being made whole in all but the smallest bank failures. With one exception (discussed below), the least-cost test effectively prevents the FDIC from covering uninsured depositors in full unless an acquirer is willing to pay a sufficient premium for the uninsured deposits to make it cheaper to pay uninsured depositors in full than to leave them behind in a receivership. Depositor preference gives domestic deposits a preference over other general creditors in a receivership. Thus, no general creditor gets paid if the FDIC suffers a loss. In theory, the least-cost test and depositor preference should lead to lower losses. In certain cases, this is probably true. For example, it is hard to see how a large money-center bank that has very few insured deposits could cause the FDIC a loss.[6] However, it is probably unrealistic to believe that, as a bank gets into trouble, its creditors would not move to protect themselves by withdrawing their funds or by securing their lending. Thus, the least-cost test and depositor preference may mitigate losses by less than it would appear at first glance.[7] Indeed, since they will encourage uninsured depositors and unsecured creditors to withdraw funds from a troubled bank, they may serve to cause a liquidity problem and hasten a failure.

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[5] FDIC (1997b), p. 460.
[6] This is absent a systemic-risk determination, which is discussed below.
[7] For a full discussion of this point, see Marino and Bennett (1999).

FDICIA allows an exception to the least-cost test only when a least-cost resolution would lead to systemic risk. Because of their sheer size, regulators would probably consider using this exception were a megabank to fail. After meeting several technical requirements,[8] the FDIC may select a more costly resolution method in such a case. If a systemic-risk determination is made and a bank is resolved in a more costly manner, then the incremental cost (that is, the difference between the resolution cost and the least-cost option) is funded by one or more special assessments rather than the insurance funds. However, because the FDIC would be responsible for carrying out the resolution, and because the special assessment(s) would not be made until sometime after the resolution, the full resolution cost would likely be charged to the BIF (and possibly the SAIF) for some period of time.

In short, the legislative changes of recent years have not been tested, and *a priori* it is unclear what effect they will have on future loss and failure rates.

3. Simulation Model

Because the number of banking failures generally ebbs and flows, the model was designed to simulate periods of small, medium, and large disbursements. This was accomplished by employing a Markov-switching model, which used historical patterns of BIF disbursements to define the probability of switching among the three levels of disbursements.

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[8] To use the systemic-risk exception, the Secretary of the Treasury, upon the recommendation of a two-thirds majority of the FDIC and Federal Reserve Boards, and after consultation with the President, must find that to follow the least-cost test would lead to systemic risk.

The model then projected the financial condition of the BIF for 50 years. For each year, bank failures (and losses from failures) were projected on the basis of the state of the banking industry and random variations within each state. To capture the effects of industry consolidation that are most likely to influence the solvency of the BIF, the top 100 banking organizations were simulated individually. The rest of the industry was simulated on an aggregate basis. Premium assessments were based on the BIF's financial condition and the minimum assessment schedule mandated by FIRREA.[9] The simulation was performed 1,000 times using a Monte Carlo simulation.

3.1 Markov-switching Model

The Markov-switching model defined movements among the small-, medium-, and large-disbursement states on the basis of historical data.[10] The process identified 30 years in the small-disbursement state, 19 years in the medium-disbursement state, and 15 years in the large-disbursement state. The transition probabilities resulting from the Markov-switching model are listed in table 4. It shows that the probability of

		To		
Table 4				
Probabilities of Movement between Disbursement States				
		Small state	Medium state	Large state
From	Small state	0.883	0.117	0.000
	Medium state	0.170	0.676	0.154
	Large state	0.000	0.196	0.804

staying in a small-disbursement state, State 1, from one period to the next is high, $\hat{p}_{11} = 0.883,$ and the probability of staying in a large-disbursement state is high, $\hat{p}_{33} = 0.804.$ However, the probability of staying in a medium-disbursement state, while

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[9] Once again, this assumed no systemic-risk determinations.
[10] For a detailed description of the Markov-switching model, see Hamilton (1993).

large, is much smaller than the other two, thereby implying that it is easier to move out of a medium-disbursement state than out of either a small- or a large-disbursement state. Also of note, the data do not support direct movement between the small- and large-disbursement states.

These probabilities imply that the average length of a high-stress period for the fund was approximately 4.4 years, the average length of a moderate-stress period is approximately 3.1 years, and the average length of a low-stress period is approximately 8.7 years.

3.2 Industry Stratification

The industry was separated into three groups: top 25, top 26–100, and all other institutions. Financial data were gathered from the Call Reports for each insured commercial and savings bank.[11] For institutions that were subsidiaries of bank holding companies (BHCs), all banks under a common BHC were aggregated to proxy the banking assets in the banking family.[12] The banking families were then separated into the top 25, top 26–100, and all others. The group of "all others" was summed, and small percentages of the total were removed each year to proxy small-bank failures. As banking companies within the top 100 failed, failed organizations were not replaced with other companies, since the cutoffs that define the asset-size classes were based on asset size in 1997 rather than the number of organizations.

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[11] After separation into asset-size classes, adjustments to the data were made to remove the deposits insured by the Savings Association Insurance Fund (SAIF) from Oakar institutions. Oakar institutions hold deposits insured by both the BIF and the SAIF. When an Oakar institution fails, the cost of the resolution is split between the BIF and the SAIF on the basis of the portion of deposits insured by each fund.

[12] Although aggregation can overstate the banking assets of the banking family by not removing intercompany transactions, information about intercompany transactions is not readily available.

3.3 The Simulation Algorithm

The model calculated the balance of the BIF each year on the basis of the prior year's asset balance, losses from failures, insurance premiums, net income (after expenses) of the fund, and reserves for future failures. This section describes the calculation of each of these items and how they are combined to produce the scenarios. The Appendix describes the equations in more detail.

Losses from failures were calculated by estimating failed-bank assets and then applying loss rates. For the top 100 banking companies, specific banks were randomly selected to fail, based on the historical failure rates for each stratum (top 25 or 26–100) during each historical disbursement state (small, medium, or large). For the remaining banks, a similar procedure was used to project the portion of bank assets that would fail. For the top 100 banking companies, loss rates were randomly selected from specific historical failures, with the top 25 drawing from the five top 50 failures experienced to date and 26–100 drawing from the nine remaining failures of top 100 organizations. For the remaining banks, a random selection from historical experience for small banks was used.

Insurance premiums were calculated based on the requirements of FIRREA. Thus, a premium of 23 basis points was assessed on domestic deposits during periods when the fund balance fell below 103 basis points. If the fund balance exceeded 125

basis points, no premiums were collected. Otherwise, sufficient premiums were collected to bring the fund balance to 125 basis points.[13]

Net income (investment income less expenses) was assumed to vary according to the state of the banking industry. During the large-disbursement state (that is, periods of stress), the fund would yield no income. Net income was projected to be 2 percent of the BIF's asset balance per year during periods of medium disbursements and 4 percent per year during periods of small disbursements.

The BIF balance was calculated as BIF assets minus a reserve for future losses. Reserves are estimated to equal the losses in the current year, excluding losses for top 25 banking companies. Consistent with historical experience, this implicitly assumes that the FDIC would be unable to predict changes accurately in the condition of the industry, but that the FDIC would not reserve for very large organizations because the probability of failure is very low.

Throughout the simulation, both assets and deposits of insured institutions were assumed to grow by 3 percent per year.

3.4 Monte Carlo Simulation

The 50-year simulation was repeated 1,000 times, and the number of runs resulting in BIF insolvency determined the probability of insolvency. To ensure that the only differences in the results were attributable to changes in the assumptions for each scenario, the same series of random numbers (that is, the periods of stress, the failures,

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[13] Note that the FDIC is also required to charge higher premiums to banks that pose more risk to the fund. Thus, this formula slightly understates premium assessments. Moreover, the understatement is higher during periods of stress when more banks are in trouble.

and the loss rates) was used for each scenario. To ensure consistency across the

scenarios, the initial fund balance was set to the 1997 level for every simulation.

4. Results

The model was run several times—each with some of its assumptions changed.

4.1 December 1990 and December 1997 Structures

The model was initially run using the December 1990 and December 1997

industry structures. The results, shown in table 5, suggest that recent consolidation in

Table 5

Simulation Results—December 1990 and 1997 Structures

Model	Probability of Fund < 0 bp	Probability of Fund < 50 bp	Probability of Fund < 75 bp
1990 structure	3.9%	17.8%	43.7%
1997 structure	6.0	17.1	34.0

the industry has increased the insolvency risk to the BIF while ameliorating the risk of

the reserve ratio falling below 75 basis points. During the 1990s, concentration within

the top 25 banking organizations increased significantly, from 39.2 percent of industry

assets to 53.6 percent. With such a large percentage of the industry's assets spread

among so few organizations, the probability that the failure of one of these organizations

would cause BIF insolvency increased significantly. In addition, the probability of a

severely insolvent BIF—defined as more than 100 basis points insolvent—increased from

0.3 percent in 1990 to 1.3 percent in 1997. Although a top 25 failure would be

devastating to the BIF, companies in the top 25 fail less often compared with other banks,

and when they fail, the loss rates are lower. Therefore, a large percentage of the industry

moved from higher failure probabilities to lower failure probabilities during the 1990s.

This movement partially offset the increased risk attributable to the growth of the largest insured banking companies. It also influenced the probability of the fund reserve ratio falling below 50 basis points and 75 basis points. Compared to 1990, a series of small bank failures is now less likely to reduce the fund balance significantly.

Also of note, as stated in section 2.2 ("Liability Structure"), the funding structure of banks changed significantly during the 1990s. From 1990 to 1997, total assets grew by almost 35 percent while the BIF assessment base grew by barely 11 percent. Since the model projected BIF losses based on assets, the slower-growing assessment base resulted in a fund that was unable to replenish itself as fast as it once could. The net result of the increased consolidation, reduced failure probability, and reduced assessment base as a percent of assets was a higher probability of BIF insolvency.[14]

4.2 *Pro forma* Structure

Next, the model was run using the December 1998 industry structure adjusted for several large recent and pending mergers, as noted in section 2.1 ("Size: Consolidation within the Industry").[15] Compared with the December 1997 structure, the consolidation during 1998 and adjustments for the pending mergers effectively moved $68.3 billion in

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[14] The liability structure can also have a significant effect on the losses incurred by the BIF. It appears that some of the change in the industry's liability structure may reduce the BIF's losses as banks shift toward funding sources that would typically incur losses were the institution to fail. When a bank becomes troubled, however, the composition of its liabilities tends to shift toward secured and FDIC-insured funding sources (thus shifting losses to the BIF). Therefore, it is difficult to predict how the changes in the industry's funding composition will affect future loss rates.

[15] The assets and liabilities of the institutions were merely summed. As of year-end 1998, the funding structure of large banks is different from that of smaller banks, with larger banks holding proportionally fewer deposits. It is unknown, however, if the difference in funding is based on the banks' desire to have fewer deposits or on an inefficiency of deposits to fund the desired level of bank size. Therefore, the liability structures of the merged institutions were not adjusted.

assets from smaller institutions into the top 25 (where failures occur less often).[16]

However, this only increased the concentration within the top 25 from 53.6 percent of

industry assets to 55.2 percent. More importantly, the top 25 organizations fell to only

20 companies in the *pro forma* scenario. In December 1997, the average top 25

organization held $103.4 billion in assets; in the *pro forma* structure, the average top 25

organization held $145.0 billion in assets—an increase of 40 percent. While there were

fewer large companies and therefore a lower probability that a large company would fail,

the mergers increased the likelihood that the failure of one very large organization would

bring down the BIF. Put differently, before the mergers, the probability that two top 25

companies would fail during the same year was extremely low. But, if these two top 25

companies merged, the resultant combined banking organization had a far greater

probability of failing than both of the formerly separate companies would fail in the same

year. When top 25 organizations merged, therefore, the risk of BIF insolvency increased.

Since the top 25 companies fail so infrequently, most years in the simulation had

fewer failed assets and lower losses. Therefore, the probability of falling below other

minimum reserve ratios decreased. The net result, shown in table 6, was a slight increase

in the probability of insolvency and a slight decrease in the probability of falling below

other minimum ratios.

	Table 6		
Simulation Results—*Pro forma* Scenario			
Model	**Probability of Fund < 0 bp**	**Probability of Fund < 50 bp**	**Probability Of Fund < 75 bp**
1997 structure	6.0%	17.1%	34.0%
Pro forma	6.5	16.6	32.1

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[16] The top 25 organizations in the *pro forma* simulation hold $314.5 billion more than the top 25 in the 1997 structure simulation. Of this, $246.2 billion is considered banking industry growth during 1998. Therefore, the mergers only moved $68.3 billion into the top 25.

Another important result was that the level of insolvency deepened materially. For the 1997 simulation, 13 insolvent runs (21.7 percent) had a minimum BIF level below negative 100 basis points. But the *pro forma* simulation projected 25 insolvent runs (38.5 percent) below negative 100 basis points. Whereas the number of insolvencies increased only from 60 to 65, the average level of insolvency deepened from 70.8 basis points to 101.0 basis points.

4.4 Profiles of Simulated Insolvencies

As industry concentration has increased, the nature of the BIF's risks has changed. To better understand these changes, the years that triggered insolvency were examined. More specifically, for each of the years that caused insolvency, the largest bank failure was flagged. Table 7 presents the results. Although the simulation using the

Table 7			
Number of Years When BIF Became Insolvent (1,000 runs)			
Largest Failure	**1990 Industry**	**1997 Industry**	***Pro forma***
Top 25	27 (69.2%)	55 (91.7%)	64 (98.5%)
Top 26—100	12 (30.8%)	5 (8.3%)	1 (1.5%)
All others	0 (0.0%)	0 (0.0%)	0 (0.0%)
Total	**39**	**60**	**65**

1990 industry structure had the fewest number of insolvent years, it had the largest percentage of the BIF insolvencies that occurred with no top 25 failures. In the simulation for the 1997 industry structure, the number of BIF insolvencies increased but, more noticeably, the percentage of insolvencies that included top 25 failures increased far more—from 69.2 percent to 91.7 percent. In the 1998 *pro forma* scenario, an even higher percentage of insolvencies occurred in years with a top 25 failure (98.5 percent). This result suggests that the risk to the BIF is becoming inseparable from the health of the top 25 organizations. If a top 10 organization fails, there is a 12.5 percent chance that the

failure will cause the BIF to become insolvent.[17] To clarify the implications for the BIF, the model was constrained to prevent any top 10 organization from failing.[18] The results are shown in table 8. Without any top 10 failures, the probability of insolvency was

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Table 8

Probability of Insolvency—*Pro forma* Scenario

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Model	Probability of Fund < 0 bp	Probability of Fund < 50 bp	Probability of Fund < 75 bp
With top 10 failures	6.5%	16.6%	32.1%
Without top 10 failures	0.5	7.9	22.6

0.5 percent, and the probability of the reserve ratio falling below 50 and 75 basis points decreased significantly. The top 10 organizations in the *pro forma* structure held 44.0 percent of industry assets. When the model was altered to prevent top 10 failures, nearly half of the industry could never fail but the associated insurance assessments would continue to be collected. Since the remaining industry assets were spread among many institutions, the probability of BIF insolvency became minuscule. In the rare cases of insolvency, the BIF became solvent again within one or two years.[19]

4.6 Simulation Results for Alternative Assessment Schemes

Two ways to lower the probability of insolvency are to raise the designated reserve ratio (DRR) or to raise assessment rates when the BIF falls below the DRR. This section examines the BIF's sensitivity to the DRR and to the maximum assessment rate charged to banks. Using the *pro forma* simulation as the base line, the model was run

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[17] This statement is based on the results of the *pro forma* scenario.

[18] This change can also be interpreted as an assumption that: all top 10 failures would be deemed systemic failures; the full cost of resolution would be borne by the industry in the form of a special assessment; the BIF would not temporarily incur the loss until the special assessment is collected; and the special assessment would not cause additional bank failures. It is highly unlikely that all of these conditions would prevail absent legislative changes.

[19] Of the five insolvent years, the largest insolvency was negative 26.4 basis points. All others would have returned to solvency within one year.

under several alternatives. Table 9 provides the results with various DRRs, and table 10

provides the results with various maximum assessment rates.[20]

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Table 9
Simulation Results—*Pro forma* Scenario
Various Designated Reserve Ratios

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Designated Reserve Ratio	Probability of Fund < 0 bp	Probability of Fund < 50 bp	Probability of Fund < 75 bp
145	5.0%	11.2%	18.5%
135	5.9	14.2	25.2
125	6.5	16.6	32.1
115	7.8	20.2	42.0
105	8.9	25.5	53.4

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Table 10
Simulation Results—*Pro forma* Scenario
Various Maximum Assessment Rates

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Maximum Assessment Rate	Probability of Fund < 0 bp	Probability of Fund < 50 bp	Probability of Fund < 75 bp
33	5.3%	10.5%	18.9%
28	5.6	13.5	25.1
23	6.5	16.6	32.1
18	8.5	21.8	44.2
13	12.9	33.5	57.8

The results show that small changes to the assessment rate or the DRR would

bring about only minor changes to the risk profile of the BIF. In other words, the FDIC

could not materially improve the risk profile of the BIF by making minor adjustments to

either the DRR or the assessment rate.   Even a significant increase in the DRR or the

assessment rate would still leave the BIF vulnerable to insolvency risk. This is consistent

with the finding that the risk of severe insolvency has increased with the advent of

megamergers.

Note that a large reduction in the assessment rate is more damaging to the BIF

than a large reduction in the DRR. If the maximum assessment level was decreased, the

fund could not build up as fast as before, and even with a high DRR, the probability of

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[20] The model implicitly assumes that an increase in the maximum assessment rate does not provoke
additional bank failures. If this assumption does not hold true, then the results will be less sensitive to

insolvency increased. For example, when the reserve ratio was increased to 145 basis points and the maximum assessment rate was decreased to 13 basis points, the probability of insolvency increased from 6.5 percent to 9.7 percent. However, when the reserve ratio was decreased to 105 basis points and the maximum assessment rate was increased to 33 basis points, the probability of insolvency decreased to 6.0 percent.

5. Conclusion

Merger activity in the 1990s appears to have increased the risk to the BIF. Moreover, the health of the BIF has become more and more dependent on the health of the top 25 banking organizations, and future insolvency may be deeper, and harder to emerge from, than in the past. Thus, it would appear to be incumbent on the FDIC to seek ways to mitigate this risk, by carefully monitoring the health of the nation's largest banking organizations, or perhaps by exploring other risk-reduction strategies.

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changes in the maximum assessment rate.

Appendix
The Simulation Algorithm

The model determined BIF assets using the algorithm in the equation

$$TA_t = (1+i)TA_{t-1} + (1+\tfrac{i}{2})(Prem_t - (LR_t)FBA_t) \qquad (1)$$

where TA_t defines the total assets of the insurance fund at the end of time t; i defines the net return on assets of the insurance fund; $Prem_t$ defines assessments during time t; LR_t defines the loss rate on failed-bank assets during time t; and FBA_t defines the failed-bank assets during time t. Each of these terms is explained in the following pages.

Assessments

The model calculated assessments according to the requirements in FIRREA. FIRREA requires that if the level of the insurance fund drops below 125 basis points of insured deposits, the industry shall be assessed a premium to increase the level of the fund. If one year's assessments do not bring the fund balance to 125 basis points, the assessment rates must accord with a recapitalization schedule that will return the fund to the proper level within 15 years. While this schedule is in force, the assessment rate must be at least 23 basis points.

The premiums assessed during a period were based on the formula

$$Prem_t = max(0, min(AR * AB_t, RR - (BIF_{t-1} - (LR_t)FBA_t - R_t + R_{t-1} + E_t))) \qquad (2)$$

where AR is the maximum assessment rate, AB_t is the assessment base at the end of time t after failed institutions are removed, RR is the required reserve level, BIF_{t-1} is the beginning fund balance, R_t is the reserves for future bank failures, R_{t-1} is the reserves from the prior year, and E_t is an adjustment for earnings expected during the period

(assuming a half year's earnings for assets spent on resolutions and a full year's earnings on the remaining assets).

To illustrate the formula, table A-1 shows three examples of premiums when the minimum required level (RR) is 125 basis points and the maximum assessment rate $(AR * AB_t)$ is 23 basis points. For the sake of clarity, all values in the table have been adjusted to be a percentage of insured deposits, and the earnings adjustment (E_t) is assumed to be 0. For periods when the BIF level was equal to or greater than 125 basis

Table A-1

BIF Balance (BIF_{t-1})	Losses $((LR_t)FBA_t)$	Change in Reserves $(R_t - R_{t-1})$	Formula	Premium $(Prem_t)$
150	30	25	$Prem_t = max(0, min(23, 125 - (150 - 30 - 25)))$	23
150	20	15	$Prem_t = max(0, min(23, 125 - (150 - 20 - 15)))$	10
150	10	5	$Prem_t = max(0, min(23, 125 - (150 - 10 - 5)))$	0

Examples of Premium Formula

points, no assessments were made. For periods when the BIF level is equal to or less than 102 basis points, the premium was equal to 23 basis points. For BIF levels less than 125 basis points but greater than 102 basis points, the premium was equal to the amount necessary to bring the BIF up to 125 basis points.[21]

Failure and Loss Rates

For each year from 1934 through 1997, the percentage of failed institutions within each size class was calculated. Failure rates that fell into the small-, medium-, and large-disbursement years were grouped separately. These failure rates were used to randomly determine specific failures of top 100 companies during the simulation for each given year. For the smaller banks, the proportion of bank assets that fail varied randomly, depending on the disbursement state.

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[21] The Federal Deposit Insurance Corporation Improvement Act of 1991 requires that high-risk institutions pay higher premiums, even when the fund is fully capitalized. Therefore, the model slightly underestimates

More specifically, the model determined failures on the basis of the formula

$$FBA_t = \sum_{i=1}^{25}(Fail_{i,t} * Asset_{i,t-1}) + \sum_{i=26}^{100}(Fail_{i,t} * Asset_{i,t-1}) + SFail_t * SAssets_{t-1} \qquad (3)$$

where FBA_t defines the total assets failed during year t; $Fail_{i,t}$ is assigned a value of 0 if

the specific company's probability of survival is greater than its probability of failure for

year t—otherwise it is assigned the value of 1;[22] $Asset_{i,t-1}$, for i between 1 and 25, is the

asset balance for the ith top 25 organization in existence at the beginning of year t, and for

i between 26 and 100, it is the asset balance for the ith top 26–100 organization in

existence at the beginning of year t; $SFail_t$ is the percentage of "all other" institutions that

will fail during year t; and $SAsset_{t-1}$ is the total assets of "all other" institutions in

existence at the beginning of year t. For simplicity, further references to $Fail_{i,t}*Asset_{i,t-1}$

will be called $FAsset_{i,t}$ and further references to $SFail_t*SAsset_{t-1}$ will be called $FSAsset_t$.

The application of failure rates differed between the top 100 and the "all other"

institutions. For the top 100 organizations for a given disbursement state, the model

randomly selected a year from the period that defined the disbursement state. That year's

experience determined the probability of a bank's failure. From a uniform distribution,

each company was assigned a random number between 0 and 1, which is defined as that

company's probability of survival. If an institution's probability of survival was less than

or equal to the probability of failure, that company failed. For example, if three

companies had probabilities of survival equal to 0.02, 0.10, and 0.85 and the year's

experience was a 4 percent probability of failure, the company with a probability of

survival of 0.02 failed, while the other two survived.

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assessment premiums. The underestimation is somewhat larger during periods of stress, when more banks are troubled.

For "all other" institutions for a given disbursement state, the model randomly selected a year from the period that defined the disbursement state. For an estimate of failures, that year's percentage of **banking assets** failed was then applied to "all other" banking assets.

The projected failures of the top 100 organizations are summarized in table A-2.

Table A-2

Bank Failures during the Simulation (1,000 runs of 50 years)

Disbursement State	Number of Years	Number of Top 25 Failures	Prob. of Top 25 Failure	Average Number of Top 25 Orgs.	Number of Top 26–100 Failures	Prob. of Top 26–100 Failure	Average Number of Top 26–100 Orgs.
Low	25,341	0	0.00	24.7	726	2.86	72.4
Medium	14,566	0	0.00	24.4	1,508	10.35	71.0
High	10,093	1,270	12.58	23.9	6,868	68.05	68.8
Total	50,000	1,270	2.54	24.4	9,102	18.20	71.3

During any given simulation run, the probability of a top 25 banking company failure during a specific year was 2.54 percent, while the probability of a top 26–100 organization failure during a specific year was 18.20 percent.[23]

Once the failed assets had been determined, the model determined losses to the BIF using the equation

$$(LR_t)FBA_t = \sum_{i=1}^{25}(FAsset_{i,t} * LRate_t) + \sum_{i=26}^{100}(FAsset_{i,t} * LRate_t) + FSAsset_t * SLRate_t \quad (4)$$

where $(LR_t)FBA_t$ defines the net losses to the insurance fund during year t; $LRate_t$ is the loss rate for top 100 organizations during year t;[24] and $SLRate_t$ is the loss rate for "all other" institutions during year t.

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[22] For each year, the probability of failure for the top 25 organizations differed from the probability for the top 26–100 organizations.

[23] These probabilities are slightly lower than expected, given the inputted probabilities. This difference is due to the nonreplacement of failed companies. As top 100 companies fail, they are not replaced and the top 100 are left with fewer than 100 members, as shown in the columns "Average Number Top 25 Orgs." and "Average Number Top 26–100 Orgs.".

[24] For each year, the loss rate is different for the top 25 and the top 26–100 organizations, but it is the same for each member within each size group.

The methodology for determining loss rates differed only slightly between the top 100 and "all other" institutions. Once the failed banking assets were determined, the model randomly selected loss rates to determine the charge to the BIF. For top 25 failures, the model selected one of the historical top 50 bank failure loss rates.[25] For the top 26–100 failures, the model selected one of the historical top 51–100 bank failure loss rates.[26] (The reason for segmenting at 50 instead of 25 is that only two top 25 companies have ever failed, so a segmentation at 25 would have too few options from which the model would pick.) For "all other" failed assets, the model used the historical loss rate for all small bank failures during the same year that determined the proportion of "all other" bank assets that failed.

BIF Reserves

The only substantive liabilities of the BIF are reserves for future bank failures,[27] which were determined by

$$R_t = \sum_{i=26}^{100} (FAsset_{i,t} * LRate_t) + FSAsset_t * SLRate_t. \qquad (5)$$

Note that equation (5) is similar to equation (4), which was used to determine the losses to the BIF for the given year, as defined in the previous section. The difference is the exclusion of top 25 failures. The model did not reserve for any top 25 failures, since the probability of a top 25 failure is very low. Thus, the balance of the bank fund was

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[25] A top 25 failure, if determined to be a systemic-risk failure, would be completely or partially funded through a special assessment. This is taken into account in the model by the possibility of a low or 0 loss rate.

[26] Since failing banks experience asset runoff during the years before failure, the loss rates were calculated using total assets two years before failure. For example, if a bank failed with $100 million in assets, if the cost to the BIF was $12 million, and if two years before failure the bank had $120 million in assets, the loss rate used in the model would be 10 percent and not 12 percent.

[27] Another liability that could become material is borrowing for working cash. However, this is offset by the value of assets held in receivership. Because the FDIC passes a large portion of assets at resolution

determined by

$$BIF_t = TA_t - R_t \tag{6}$$

where BIF_t defines the fund net balance at the end of time t; TA_t defines total assets in the fund at the end of time t; and R_t defines the reserves for troubled banks that are set aside in time t.

By using losses to the BIF from one year as the loss reserves for the next year, the model implicitly assumed that the FDIC will not be able to accurately predict changes in its environment right away. This method of adaptive reserving over-reserves when a small disbursement follows a large disbursement and under-reserves when a large disbursement follows a small disbursement, a pattern that matches recent history. For example, at the end of 1991 the FDIC reserved $15.4 billion to cover expected losses of the banks that were identified as likely to fail. At that time insurance fund assets were depleted, and reserving the large amount caused the BIF to become insolvent. However, actual losses were $3.7 billion in 1992 and $677 million in 1993.

In addition, the model's adaptive reserving corrected itself within one year of the change from one disbursement state to the other. For example, as the disbursement state moved from a period of large losses to a period of moderate losses, the model reserved for a future large loss. Since the next period had a moderate loss, the model over-reserved and adversely affected the insurance fund. After this first period of moderate losses, the model correctly reserved for the next moderate loss. Therefore, initially the model did not properly foresee the change of disbursement states, but it corrected itself after one period. Since the probability that disbursement states will change is relatively

(particularly for large institutions), the effects of working cash on the solvency of the BIF are assumed to be de minimis.

low, the chance of a series of successive periods alternating among the disbursement states, with the consequent repetitive improper reserving, is low.

Return on Assets

In equation (1), the net return on assets (i) was defined as insurance fund asset earnings in excess of operating expenses. Since 1995, the assets in the BIF have earned between 5.0 percent and 6.1 percent, averaging 5.6 percent. Expenses as a percentage of BIF assets during this period have been between 2.2 percent and 2.5 percent, averaging 2.3 percent. Hence, the net yield on BIF assets during this period has ranged from 2.8 percent to 3.8 percent, averaging 3.3 percent.[28] Therefore, the model assumed that the net yield on the BIF's assets would be 4 percent during periods of low disbursements, 2 percent during periods of medium disbursements, and 0 percent during periods of large disbursements.

The model assumed the premiums are assessed throughout the year and proxied this by collecting all the premiums in the middle of the year. Therefore, the premiums earned one-half of the yield that was earned by the accumulated BIF assets. In addition, the model assumed that bank failures occur throughout the year and proxies this by removing assets from the BIF in the middle of the year. Therefore, the assets removed earned one-half of the yield that was earned by the accumulated BIF assets.

Asset and Deposit Growth

The model assumed that banking assets and deposits grew at 3 percent per year. Both grew at the same rate to proxy a constant funding structure. If assets were to grow at a rate different from the rate for deposits, there would have been a *de facto* change in

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[28] One would expect the fund's yield to drop during periods of stress because BIF expenses would increase and the fund balance would drop.

banks' funding structure. The 3 percent level assumes that future industry growth will be a little slower than the current 5 percent growth. Since earnings on the fund in periods of minimal bank failure and losses are assumed to exceed the growth of deposits, the BIF would be self-sustaining without a need to assess premiums.

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