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A review from the
Federal Reserve Bank
of Chicago

Tracking Midwest manufacturing and productivity growth

Why the life insurance industry did not face an "S&L-type" crisis

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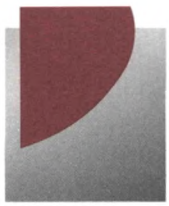
Tracking Midwest manufacturing and productivity growth

Philip R. Israilevich, Kenneth N. Kuttner, and Robert H. Schnorbus



After years of lagging economic performance that led to the region's characterization as a "rust belt," Midwest manufacturers have exhibited increasing competitiveness in the last several years, compared with the rest of the nation and with their own earlier performance.* Evidence of this strong performance is the fact that the Midwest's output grew faster on average than the nation's, given observed rates of capital and labor usage.

A common explanation for this resurgence has been that in the 1980s, Midwest manufacturers undertook aggressive modernization programs in an attempt to reverse their fortunes. This explanation, however, rests largely on anecdotal evidence; data have been hard to come by. With the help of annual production models, the mixed-frequency Midwest Manufacturing Index (MMI) developed by Israilevich and Kuttner (1993), and annual capital expenditure data from the U.S. Commerce Department, we are beginning to reach a clearer understanding of the region's improvements in productivity and competitiveness as Midwest manufacturers move into the 1990s.

In this article, we explore the reasons for the so-called takeoff in Midwest manufacturing productivity, tracing its growth to significant modernization efforts in several key industries. Investment data and estimates of production models both suggest that productivity gains were higher in the region than in the rest of the nation. We then use the mixed-frequency MMI to assess the quantitative significance of the increased productivity growth for current estimates of Midwest output.

The productivity takeoff identified in this analysis has important implications for the MMI model, which relies on historical rates of productivity growth to account for the divergence of output and employment data, and to compute current estimates of the index. In light of the evidence, we reconsider the assumption of a constant rate of productivity growth for each industry, and suggest a modification to the MMI model that will allow it to capture the technical progress that resulted from modernization of core Midwest industries.

Investment and the productivity takeoff in the Midwest

The key to regional growth is improving competitiveness, and the key to increasing a region's competitiveness is productivity growth relative to other regions. Such productivity gains can be achieved in at least two ways: faster withdrawal of the least productive capital stock (downsizing) than elsewhere, and faster introduction of new, more technologically advanced plant and equipment than elsewhere. While both measures can yield increased output per worker, they have different implications for

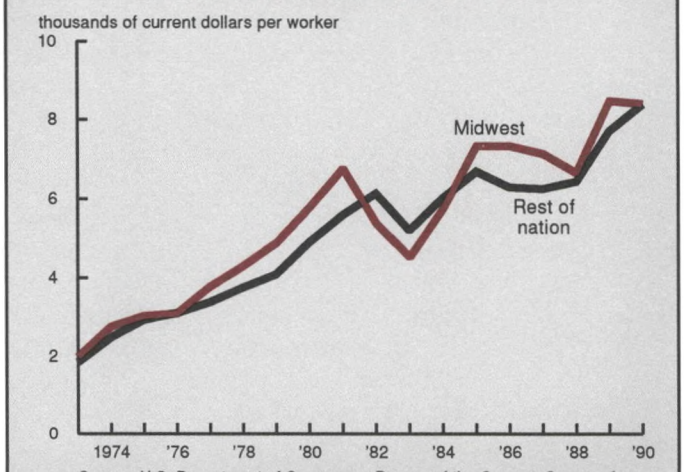
*The Midwest is defined here to include the five states in the Seventh Federal Reserve District: Illinois, Indiana, Iowa, Michigan, and Wisconsin.

Philip R. Israilevich is Senior Economist, Kenneth N. Kuttner is Senior Research Economist and Research Officer, and Robert H. Schnorbus is Senior Business Economist and Research Officer, all at the Federal Reserve Bank of Chicago.

future growth. If the recent productivity gains in the Midwest were achieved only by shrinking the manufacturing base without modernizing, the region would be vulnerable to further declines as other regions improve their competitiveness and increase their market share at the Midwest's expense. However, if Midwest manufacturers were modernizing while they were closing antiquated facilities, they might offset any net reductions in capital stock with productivity gains sufficient to allow output growth relative to the rest of the nation.

FIGURE 1

Capital expenditures per worker



Source: U.S. Department of Commerce, Bureau of the Census, *Survey of Manufacturers* and *Census of Manufacturers*, various issues.

In the early 1980s, manufacturers were under severe financial stress, particularly in the Midwest. A relatively deep recession in 1980–82 was followed by an intensification of global competition caused in part by a strong dollar. Many well-known companies such as Caterpillar, USG, and Chrysler were pushed dangerously close to bankruptcy; virtually all manufacturers in the Midwest scrambled to cut costs in order to be as competitive as possible in an increasingly tough global market. As part of that effort, many old or marginally profitable plants were closed under the banner of "rationalization"—a term which in the 1990s would be dubbed "re-engineering."

Despite these financial problems, many Midwest manufacturers met the increasing competitive pressures of the early 1980s with aggressive capital spending programs. While withdrawing older capital stock, they also invested in new plants and equipment. The only question was whether these adjustments were occurring at a faster pace in the region than they were elsewhere in the nation.

Before 1985, the Midwest tended to invest at roughly the same rate as the rest of the nation. Investment in the region picked up in the late 1970s but slowed again with the onset of the 1980-82 recession. Thereafter, Midwest investment lagged the rest of the nation until a push resumed in 1985.[1] As figure 1 shows, between 1986 and 1990, average capital expenditure per worker in the Midwest was 9 percent above the amount for the rest of the nation.

The Midwest contains a high proportion of capital-intensive industries, notably auto and steel, yet the difference between investment per worker in the Midwest and in the rest of nation does not appear to be due to differences in industrial mix. Indeed, both the auto and steel industries show higher investment per worker in the region than in the rest of the nation. For example, between 1986 and 1990, investment per worker in the transportation industry was 16 percent higher on average in the Midwest than in the rest of the nation; in primary metals it was 22 percent higher on average. While these two industries show larger differentials than other industries, they demonstrate that the pattern observed at the aggregate manufacturing level reflects a widespread commitment to modernization among Midwest manufacturers.

A closer look at the auto and steel industries reveals the dual nature of the adjustments that manufacturers made in response to competitive problems. During the 1980s, automakers closed seventeen car and truck assembly plants, of which six were in the Midwest. At the same time, they constructed seventeen plants, seven of them in the Midwest. Some of the new plants were essentially replacements of existing Big Three plants, for example, Chrysler's Jefferson Avenue plant in Detroit. But some were entirely new plants built by foreign auto companies, often in conjunction with a Big Three producer. Among the foreign-owned plants are the Diamond Star Plant in Illinois (Chrysler and Mitsubishi) and the Flat Rock Plant in Michigan (Ford and Mazda).

A somewhat similar pattern of investment occurred in the Midwest steel industry, where

integrated mills were closed and the remaining mills modernized. Inland Steel, for example, has invested roughly $1 billion since 1985 to modernize its Indiana Harbor Works in East Chicago, Indiana (which included converting to continuous casting). The company spent another $1 billion on a new mill in Indiana, a joint venture with a Japanese producer. While integrated steel producers were modernizing, they were also opening mini-mills that brought a wholly different production process to U.S. steelmaking.

The result was that both the auto and steel industries saw more productivity gains in the Midwest than in the rest of the nation. These gains made Midwest producers more competitive and allowed industry in the region to grow faster than elsewhere.

Productivity growth in the Midwest: evidence from annual data

The investment patterns noted above suggest that Midwest manufacturers began to modernize aggressively around 1986. What is lacking is some measure of how much efficiency increased as a result. How much has Midwest manufacturing output grown, compared with the growth that would have occurred using pre-1986 technology?

One way to address this question is simply to compare the out-of-sample forecasts from a production function estimated on data from 1973 through 1985 with observed output from 1986 to the present. A natural and intuitive measure of the size of the takeoff is the difference between the Midwest's observed output and the model's prediction: that is, the amount by which actual output exceeds what would have been produced had pre-1986 technology been applied to the actual factor inputs.

A convenient production function for this analysis is the Cobb-Douglas specification,

$$x_t = \gamma \cdot t + \theta l_t + \phi e_t + \eta_t,$$

where x represents output of a given industry measured by the logarithm of real value added (VA), t indexes the year, l is the logarithm of payroll employment, and e is the logarithm of electricity consumption. For applications such as this, energy consumption is widely interpreted as a proxy for the utilized stock of capital.[2] The γ coefficient on the time trend represents the rate of Hicks-neutral technological change (i.e., productivity not embodied in either labor or capital inputs), θ and ϕ are the elasticities of output with respect to labor and capital, and η is a random error term. The Cobb-Douglas specification is also consistent with the mixed-frequency MMI introduced subsequently, as well as a variety of other indices discussed in Israilevich *et al.* (1989).

We first estimated the production function over the sample running from 1973 through 1985, dates chosen on the basis of the Midwest investment patterns discussed above. Using this estimated function, we then projected output for the 1986–90 period on the basis of pre-1986 "old" technology, and compared the projection to the actual VA data, the result of production with "new" technology.

The Midwest versus the nation

Table 1 reports the difference between projected and observed output growth for 15 key manufacturing industries in the Midwest, aggregated into five sectors: transportation, metalworking, machinery, chemicals, and consumer products. Table 2 shows the composition of these sectors and a breakdown of Midwest output by industry. For comparison purposes, similar calculations were done for the rest of the nation. According to these estimates, between 1986 and 1990, Midwest manufacturing sectors improved efficiency by 8 percent more than the corresponding sectors in the rest of the nation. Given the capital-intensive nature of most Midwest industries and their relative maturity, such a gain is substantial. It would also help explain why output has been growing faster in the region than in the nation since the late 1980s.

Figure 2 displays the efficiency gains graphically, showing the Midwest's lead as a function of time. While the gap between observed and

TABLE 1

Efficiency gains, 1986-90
(percent)

Sector	Midwest	Rest of nation
Transportation	7.94	3.83
Metalworking	2.03	2.38
Machinery	2.01	0.89
Chemicals	0.76	3.10
Consumer products	–3.33	–0.58
Total	**1.38**	**1.28**

TABLE 2

Composition of Midwest manufacturing output, 1990

Sector	Share (%)	Industry	Share (%)
Transportation	14	Transportation (SIC 37)	14
Metalworking	14	Primary metals (SIC 33)	5
		Fabricated metals (SIC 34)	8
Machinery	36	Nonelectrical (SIC 35)	26
		Electrical (SIC 36 and 38)	10
Chemicals	15	Chemicals (SIC 28)	8
		Petroleum (SIC 29)	1
		Rubber and plastic (SIC 30)	5
		Clay, glass and stone (SIC 32)	1
Consumer products	22	Food (20)	11
		Lumber and wood (SIC 24)	1
		Furniture and fixtures (SIC 25)	2
		Paper products (SIC 26)	3
		Printing and publishing (SIC 27)	4
		Miscellaneous (SIC 39)	1

Note: Industry subtotals may not equal sector totals because of rounding.

predicted output remained positive, it flattened out in 1989 and declined in 1990. Only in 1990 did the rate of improvement in efficiency seem to subside, both in the Midwest and elsewhere. This pattern suggests that the shift in the national economy from a mini-boom in 1988–89 (roughly 4 percent real GDP growth) to virtual stagnation (roughly 1–2 percent real GDP growth) had an impact on efficiency gains. Perhaps the cyclical drop in output growth prior to the 1990–91 recession led to underutilization of labor and capital, which reduced the measure of efficiency gains over the second half of the 1980s. Moreover, the commitment to efficiency gains even in a sluggish economy may help explain why manufacturers have been able to expand output since the 1990–91 recession even though employment growth has been virtually nonexistent.

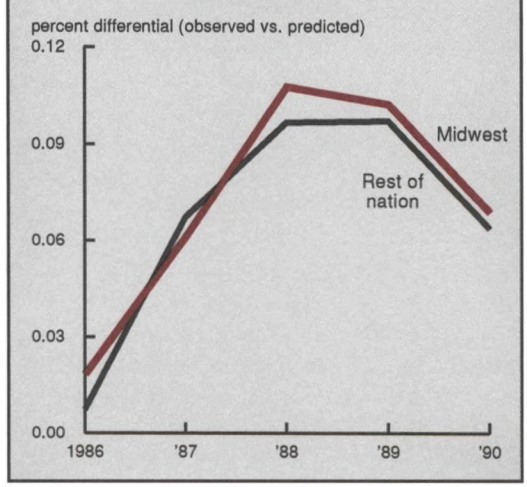
Comparisons between Midwest industries

The efficiency gains identified in table 1 were clearly not uniform across the Midwest's industries. How widespread were they, and how much of the total gain was due to the industrial structure of the region relative to the rest of the nation? The gains did seem to be concentrated in the region's core manufacturing sectors, transportation and machinery.

The Midwest's transportation sector scored the most impressive gains in efficiency. Output in this sector was 7.9 percent higher than forecast on the basis of pre-1986 technology, compared to 3.8 percent higher in the rest of the

FIGURE 2

Efficiency gains



nation. In the Midwest, the transportation sector is dominated by automobile manufacturers and parts suppliers, both of which were troubled industries throughout the 1980s. Japanese imports and nameplates produced in the U.S. had been gaining market share for many years, leaving the domestic industry with tremendous overcapacity. The first wave of restructuring took place in the early 1980s when Ford and Chrysler began closing plants. GM began closing assembly plants in the late 1980s and is currently in a second wave of closings that will extend into 1995. At the same time that Big Three automakers were closing plants, both they and the Japanese were opening state-of-the-art assembly plants in the Midwest as well as elsewhere. Over the 1980s, the region's share of total car production actually rose from 39 to 44 percent, although its share of truck production declined from 40 to 28 percent.

The Midwest's machinery sector also outpaced the rest of the nation. While in the rest of the nation machinery was on average 0.9 percent above its predicted level of output over the 1986–90 period, in the Midwest it was 2 percent higher than predicted on the basis of the pre-1986 technology. The region's machinery sector is largely focused on the auto industry and exports. As suppliers of the new capital, this sector has been in the forefront of the recent wave of investment targeted to meet global competition. Machinery producers themselves have faced stiff competition from foreign competitors, particularly the Japanese. Moreover, some machinery producers have been bought out by foreign companies, a change that often brings an infusion of fresh capital that improves productivity. It is encouraging to see that machinery producers, especially in the Midwest, have accepted the challenge of heightened global competition by increasing capital expenditures rather than by closing or shifting to other markets.

In the aggregate, the Midwest's metalworking sector displayed efficiency gains roughly in line with the rest of the nation. However, disaggregating the sector into its two constituent industries, fabricated metals and primary metals (the steel industry in the Midwest) reveals an interesting contrast. While the pace of technical change lagged the nation in fabricated metals, productivity growth in primary metals exceeded the nation's—a divergence that also appears in the MMI results presented later in this article. Interestingly, the major downsizing in the steel industry was over by the mid-1980s, leaving the Midwest as the dominant integrated steel-producing region. Midwest firms continued investing in modernization, and even mini-mills were expanding in the region. It is the Midwest's continued modernization, and perhaps its dominance in the high-quality steel produced by integrated mills, that allowed the region to outpace the rest of the nation in productivity. In contrast to primary metals, the metal fabrication industry, which produces finished parts from raw steel, never experienced any significant consolidation. The small size of producers in this fragmented industry may have limited the adoption of technical advances.

While efficiency gains were clearly widespread in the Midwest, not all the region's industries outpaced their counterparts elsewhere in the nation. The Midwest's chemical and consumer products sectors actually lagged the rest of the nation in efficiency gains over the 1986-90 period. In fact, efficiency in the latter sector was lower during the period than in previous years. While these industries are important to the Midwest, it is interesting that they are generally outside the auto-steel-machinery complex that comprises the heart of the region's manufacturing. It is perhaps unfortunate that strength in this "heart" seems not to spill over into other industries, yet by the same token, it seems that weakness in some sectors does not retard efficiency gains in other sectors.

The productivity takeoff and the MMI

The preceding section discussed measuring Midwest productivity gains by comparing annual VA data with predictions from estimated production models. An alternative method is to apply a similar analysis to predictions generated by the mixed-frequency MMI, as described in the appendix. The main advantage of the mixed-frequency MMI is that it tracks actual VA more precisely than other purely annual indices, such as the annual Cobb-Douglas or Atlanta methods, when projected out of sample.[3] Hence, the MMI should yield a more accurate assessment of Midwest efficiency gains than the annual model.

A second reason to use the MMI in this context is to examine any implications the hypothesized productivity takeoff might have for current estimates of Midwest output. Although the production model underlying the mixed-frequency MMI is re-estimated as new annual VA data become available, an increase in the

rate of technical progress may require structural modifications to the model to enable it to track manufacturing output more accurately in the future.

Out-of-sample comparisons

To construct a quantitative measure of Midwest efficiency growth, we first estimated the mixed-frequency MMI using annual data from 1973 through 1985. We then used monthly energy, labor, and nationwide Industrial Production (IP) data to project the MMI forward over the 1986–90 period, in which annual real VA data for the Midwest are available. Comparing the projected series with the actual VA data yields an index of efficiency gains that is comparable to the measures reported earlier. As before, an increase in the rate of productivity growth would imply that the projected MMI would underpredict output growth. This shortfall, therefore, represents the region's gains expressed in terms of the additional output produced as a result of increased manufacturing productivity.

Table 3 reports these gains, classified by industries and sectors. The results are expressed as the average percentage deviation between observed real VA growth and the annualized growth rate of the projected MMI. In metalworking, for example, the reported 0.6 percent figure signifies that on average, the MMI underpredicted VA growth by 0.6 percent for each year in the 1986–90 period.

The results are broadly similar to those based on the annual estimates reported above. Most striking is the spectacular productivity growth in the transportation sector, which consists entirely of SIC 37. Here, annual productivity growth over 1986–90 was roughly 9 percent higher than in the preceding 13 years. To restate this in cumulative terms, by the end of 1990, output in the transportation sector was about 40 percent higher than it would have been had firms applied pre-1986 technology to the same labor and energy factor inputs. Such are the quantitative effects of the investment flows and modernization efforts identified earlier.

Although there are a few bright spots, none of the other sectors showed the kind of spectacular growth detected in transportation. Echoing the earlier annual results, within metalworking, primary metals (SIC 33) did well, turning in a robust average 2.8 percent per year increase in

TABLE 3

Efficiency gains based on the MMI, 1986-90

Sector	Gain (%)	Industry	Gain (%)
Transportation	9.0	Transportation (SIC 37)	9.0
Metalworking	0.6	Primary metals (SIC 33)	2.8
		Fabricated metals (SIC 34)	–0.8
Machinery	–0.6	Nonelectrical (SIC 35)	–0.9
		Electrical (SIC 36 and 38)	0.2
Chemicals	–0.9	Chemicals (SIC 28)	–0.3
		Petroleum (SIC 29)	–5.7
		Rubber and plastic (SIC 30)	0.4
		Clay, glass and stone (SIC 32)	–4.0
Consumer products	–1.6	Food (SIC 20)	–0.1
		Lumber and wood (SIC 24)	5.5
		Furniture and fixtures (SIC 25)	–3.7
		Paper products (SIC 26)	–6.0
		Printing and publishing (SIC 27)	–0.6
		Miscellaneous (SIC 39)	–9.6

its rate of productivity growth. The slight deterioration in fabricated metals (SIC 34) partly offset this gain, however, resulting in a modest overall gain for metalworking of only 0.6 percent.

Neither machinery nor chemicals displayed any significant evidence of a productivity acceleration. The small improvement in machinery sector productivity evident in the annual results is not apparent in the MMI. The rates of technical change in both nonelectrical (SIC 35) and electrical machinery (SICs 36 and 38) remained close to pre-1986 levels. The rate of technical change also appeared stable in the chemical sector, with chemicals (SIC 28) and rubber and plastic (SIC 30) indices tracking VA quite closely. The exceptions were petroleum (SIC 29) and clay, glass and stone (SIC 32), whose performance appeared to deteriorate significantly. However, given the poor quality of the data and the very small size of these industries in the Midwest (each only about 1 percent of 1990 VA), little weight should be given to these results.

Performance within the consumer products sector was rather disappointing overall. All industries showed some diminution in their rate of technical change, with the exception of lumber and wood (SIC 24). Since that industry currently accounts for only 1 percent of the Midwest's output, its impact on the region is small.

TABLE 4

Estimated shift in Midwest rate of productivity growth
(annualized percentage)

	1973-85	1986-90	Difference
Transportation (SIC 37)	0.1	10.0	9.8*
Primary metals (SIC 33)	0.4	4.1	3.7

* significant at the .05 level.

Modeling the productivity takeoff

How important are these results statistically? How might the mixed-frequency MMI model be extended to allow a changing rate of productivity growth? What is the impact of more rapid technical change on current estimates of the MMI? To address these three issues, we re-estimate the MMI for the transportation and primary metals industries—the two industries that show significant acceleration in the region—allowing a shift in the productivity growth rate in 1986. The significance of this shift can then be evaluated statistically.

The results of this exercise, as reported in table 4, generally support the out-of-sample findings. Again, the evidence for a productivity takeoff is strongest for transportation, which experienced a statistically significant increase in annual productivity growth of 10 percent relative to the 1973–85 period. If this more rapid growth were extrapolated into 1993, then with the same inputs, output (measured by VA) would be roughly 70 percent higher than it would have been using 1973–85 technology.

The results for primary metals also provide some evidence for a higher productivity growth rate, although the statistical significance is weaker. While the estimated shift coefficient implies an increase in annual productivity growth of 4 percent, it is not statistically significant at the traditional .05 level.

Extending the MMI

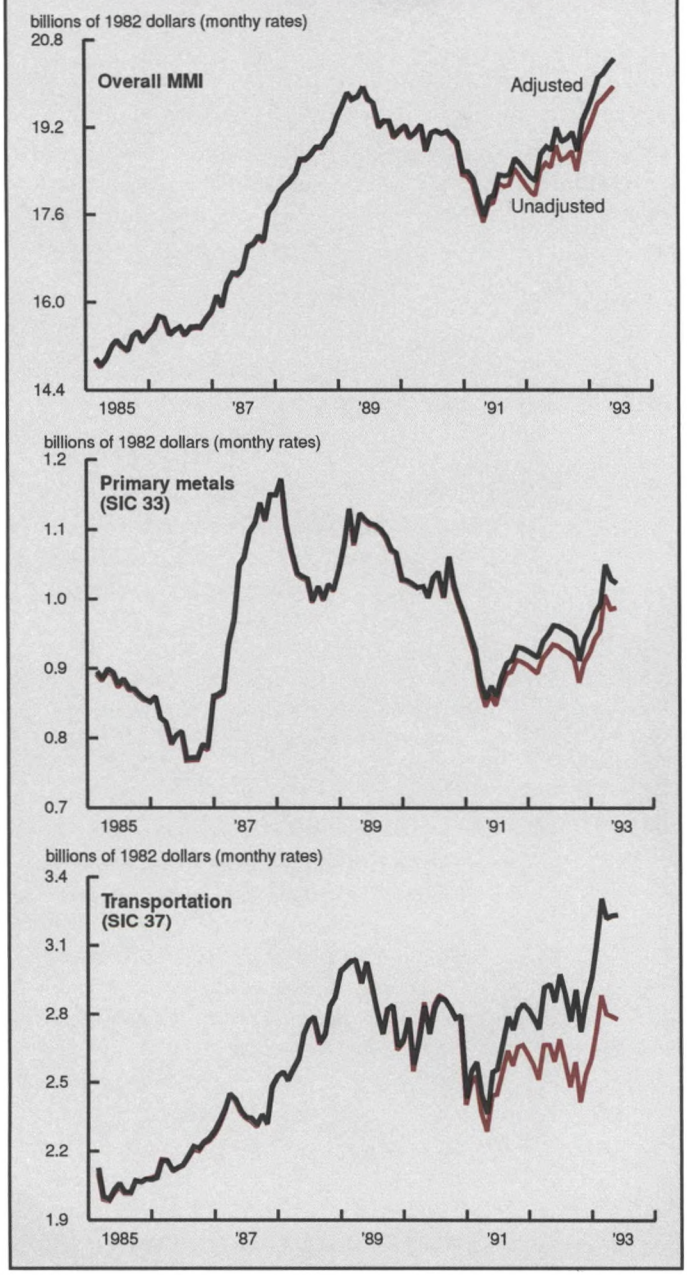
These findings have potentially important implications for current appraisals of Midwest output. One of the purposes of the MMI is to assess the level of manufacturing activity prior to the release of VA data, which become available after a two- to three-year lag. Contemporaneous estimates of the growth of industry output incorporate a weighted average of energy and labor inputs, plus the rate of productivity growth relevant for that industry. Updates of the MMI, therefore, depend critically on whether this rate of productivity growth is stable. Projections that did not take into account any productivity acceleration might as a result seriously understate current output levels.

To assess the consequences on the MMI, we perform one final exercise, comparing post-1990 MMI projections with and without a shift in productivity growth in 1986. Rather than re-estimate the model for every industry, we again concentrate on the two showing some evidence of a productivity takeoff: primary metals (SIC 33) and transportation (SIC 37). The results appear in figure 3.

The top panel shows the impact of this change on the aggregate MMI. The effect is small but perceptible. The cumulative discrepancy relative to the unadjusted index was

FIGURE 3

Effect of the productivity takeoff on the MMI



2 percent as of April 1993. Naturally, the effects on the individual industries, depicted in the middle and bottom panels, are larger. As expected in light of the earlier results, the most pronounced effect is in transportation, where the adjusted MMI is 15 percent higher than the unadjusted by April 1993. The cumulative impact on primary metals is a smaller but still substantial 3 percent.

These results demonstrate that if the productivity acceleration had continued from 1990 to the present, it may have had a noticeable impact on the MMI; accordingly, the existing MMI would have understated the Midwest's actual output from 1991 to 1993. Should the index then be modified to incorporate higher rates of productivity growth in certain industries? Clearly, the answer depends on recent productivity developments. For example, if we assumed that the 1986–90 rate of change had continued into 1993 but it had actually levelled off, then modifying the MMI would introduce an upward bias into it. For this reason, the appropriate incorporation of changes to the MMI model requires an ongoing, disaggregated examination of the structure of the economy.

Conclusion

Despite falling levels of employment, Midwest manufacturing output expanded rapidly during the 1980s. This growth, which surpassed national output growth over the period, suggests improved competitiveness among the region's manufacturers. The evidence confirms this impression. Comparing the predictions of production models applied to annual Midwest data with similar predictions for the rest of the nation showed that the region's brisk expansion was due in large part to strong productivity growth. The main cause of this growth appears to have been the aggressive modernization efforts of Midwest manufacturers, as reflected in the region's higher rate of investment per worker relative to the national average.

Using the MMI to evaluate the size and scope of the productivity gains, we found that they were largely confined to a few key industries, particularly transportation and primary metals. However, given the prominence of these industries in the Midwest, their impact on overall manufacturing output is substantial, possibly raising current

estimates in excess of 2 percent if the productivity growth observed from 1986 through 1990 continued into 1993. This finding underlines the importance of incorporating higher rates of technical change for certain industries into future updates of the MMI to reflect the continuing modernization of Midwest manufacturing.

APPENDIX

Tracking Midwest manufacturing with the mixed-frequency MMI

A useful tool for analyzing Midwest manufacturing is the mixed-frequency Midwest Manufacturing Index (MMI) developed by Israilevich and Kuttner (1993). While this technique uses the Cobb-Douglas production function employed in the annual results, it differs from this specification in its use of a *monthly* production model. At the same time, it constrains the estimated monthly production series in such a way as to be consistent with the observed *annual* value added (VA) data; hence the "mixed-frequency" designation.

Incorporating monthly data yields two significant advantages over annual models. First, it makes it possible to track high-frequency fluctuations in Midwest output. Second, the mixed-frequency MMI has been shown to provide more accurate out-of-sample projections of manufacturing activity than pure annual models. Since annual VA data are not yet available for the Midwest, this benefit is particularly useful for assessing the effects of accelerated technical change on the current output of the region's manufacturing sector.

The foundation of the mixed-frequency MMI is a Cobb-Douglas production equation applied to monthly data. Expressed as first differences of natural logarithms, the monthly change in the real output of any Midwest industry, $\Delta x^7_{t,s}$, is the weighted sum of the change in employment hours, $\Delta l^7_{t,s}$, and energy usage, $\Delta e^7_{t,s}$:

$$\Delta x^7_{t,s} = \gamma + \theta \Delta l^7_{t,s} + \phi \Delta e^7_{t,s} + \eta_{t,s}\,.$$

As in the annual model, γ is the (constant) rate of Hicks-Neutral technical change, θ and ϕ represent the elasticity of output with respect to labor and capital (energy), and η is a stochastic error term. The superscript 7 is used to denote Midwest data. Note that with the shift to monthly data, each variable now receives two subscripts. The first, t, denotes the year, while the second, s, represents the month within that year. Thus the change in output between the second and third months of the 13th year of the sample would be denoted $\Delta x^7_{13,3}$.

A difficulty with this approach is that while monthly energy and labor data are available for the Midwest, no monthly output measure exists. The only available measure of region's production is the real value added (VA) data used in the annual results. In light of this data limitation, estimating the monthly model might appear to be a lost cause, since traditional regression techniques require the observations on the left-hand variable to be available at the same frequency as those for the right-hand variables. Using regression methods, therefore, requires that energy and labor be aggregated to an annual frequency. This is the approach used earlier to compare productivity growth in the Midwest and in the rest of the nation.

Fortunately, there are ways around this obstacle. Techniques exist to combine data of differing frequencies into a single model. For the mixed-frequency MMI, we use a state-space econometric model that treats Midwest output growth as a latent variable. Given some additional relationships between the unobserved $\Delta x^7_{t,s}$ and other data series, the monthly model can be estimated even in the absence of direct information on Midwest output.

One key link between $\Delta x^7_{t,s}$ and something observable is the "adding up" relationship between the monthly growth of output and the annual growth of the real VA data. Because the annual VA observations correspond to the sum of the output produced in each month, the year-to-year change in real VA is actually a weighted average of the monthly output growth in the current and preceding 23 months. Thus, constraining the monthly growth rates to produce an annual pattern consistent with the VA data implies that

$$\ln(\mathrm{VA}^7_t) - \ln(\mathrm{VA}^7_{t-1}) = \frac{1}{12} \cdot \sum_{s=1}^{12} \sum_{j=0}^{11} \Delta x^7_{t,s-j}\,,$$

Imposing this equation enforces consistency between the estimated MMI and the annual VA data.This relationship alone is not enough for the monthly approach to yield any dividends, since all the available information is still coming at an annual frequency. In order to make inferences about fluctuations within the year, we need an additional source of *monthly* information. One source of such information is the monthly index of industrial production (IP) prepared by the Federal Reserve Board. Besides the energy and labor inputs used as inputs to the MMI, the IP typically incorporates some information on actual output, such as the dollar value or physical quantity of goods shipped. Thus the IP index con-

tains information on industry output not captured by energy and labor inputs alone. However, the information in the IP index pertains to the nation, not to the Midwest. Therefore we cannot simply use IP to compute $\Delta x^7_{t,s}$. Instead, we relate national to regional fluctuations by using an equation to describe the comovement of the two series:

$$\Delta x^N_{t,s} = \mu + \delta \Delta x^7_{t,s} + \nu_{t,s} .$$

As before, $\Delta x^7_{t,s}$ represents the growth in Midwest output; $\Delta x^N_{t,s}$ is the growth of national output in the same industry as measured by industrial production. The coefficient δ relates the magnitude of the national fluctuations to those of the region, and ν is random "noise" in the relationship.

Unlike the production model introduced earlier, this equation does not describe any fundamental economic or structural relationship between the region and the nation. Neither is the national IP in any way a determinant of regional output in the same way that regional labor and energy inputs are. Rather, this equation describes how Midwest economic fluctuations have historically been paralleled by movements on a national scale.

Clearly, the fact that Midwest industry comprises a portion of the national total, implies a positive correlation between the region and the nation, represented by a positive value of δ. But to the extent that industries within and outside the region are subject to similar demand conditions, one might expect the correlation to be even greater than suggested by the industry's share in total output. It is unlikely, however, that δ would exceed 1, since many regional fluctuations will be damped by offsetting fluctuations in the rest of the nation. While the δ parameter picks up the relative magnitudes of industrial fluctuations, the standard deviation of ν captures the amount of "noise," or unpredictable variation, in the link between regional and national output.

TABLE 5

Mixed-frequency MMI model estimates for primary metals (SIC 33)

Production model	IP indicator equation
$\phi = 0.33$*	$\mu = 0.00$
$\theta = 1.11$*	$\delta = 0.54$*
$\gamma = 0.001$	Standard deviation of $\nu = 0.025$
Standard deviation of $\eta = 0.038$	

Note: Based on the 1973-90 sample.
* significant at the .01 level.

Table 5 shows the results from estimating the mixed-frequency MMI model for one representative industry: primary metals (SIC 33). The estimates of the production function's parameters all fall within the range of economically reasonable values, although the sum of ϕ and θ imply increasing returns to scale. The estimate of γ (which is constant throughout the sample) suggests only very modest productivity growth of 1.4 percent per year. The very small estimate of μ indicates that output has grown at roughly the same rate in the nation as in the Midwest. The estimated δ of 0.54, however, suggests that IP fluctuations in the nation are approximately half the magnitude of fluctuations in the Midwest.

FOOTNOTES

[1]Estimates of Midwest capital expenditures for the years 1979–81 are not available in the Commerce Department's Annual Survey of Manufacturing (ASM). Values were calculated by first comparing a sample of 480 Midwest firms with 100 or more employees, taken from the Longitudinal Research Data (LRD) base for the years 1985–88, with the reported ASM data for those years and, second, applying the average proportions to the LRD base to generate ASM-equivalent data.

[2]Moody (1974) discusses the use of energy as a proxy for capital services.

[3]A description of the Atlanta method appears in Israilevich and Kuttner (1993).

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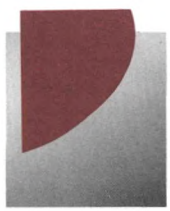
Why the life insurance industry did not face an "S&L-type" crisis

Elijah Brewer III, Thomas H. Mondschean, and Philip E. Strahan



Since August 1989, the Resolution Trust Corporation has spent $84.4 billion of taxpayers' money to close 653 savings and loan associations (S&Ls).[1] In addition, between 1986 and 1990, over 900 commercial banks were closed with assets totaling over $100 billion. On July 16, 1991, in response to policyholder runs during the previous three months totaling approximately $500 million, New Jersey regulators seized the Mutual Benefit Life Insurance Company. The asset quality problems that led to this and other runs on life insurance companies in the early 1990s have led some to wonder whether yet another category of financial intermediaries might suffer widespread failures requiring government intervention at taxpayer expense. Government closings of financial institutions can be extremely costly to taxpayers, and the safety of life insurance policies and annuity contracts is of concern to millions of policyholders. For these reasons alone, it is important to assess the risk exposure and regulatory structure of the U.S. life insurance industry.[2]

But there are other reasons as well. First, according to the Federal Reserve *Flow of Funds*, the industry held approximately $1.2 trillion in assets at the end of 1991, accounting for 11.4 percent of total financial assets. Capital adequacy or asset quality problems in this industry could lead to disintermediation, or the transfer of saving and borrowing activities from life insurance companies to other financial institutions. This in turn would result in less efficient allocation of capital. Second, most state governments bear part of the cost of an insurance failure by providing tax credits to life insurance companies (LICs) that pay guaranty fund assessments. Third, losses from failures are partially borne by insurance and pension policyholders, reducing potential income to retirees. Finally, the experiences of the life insurance industry can provide some lessons for bank regulators.

The 1980s witnessed two important changes in the mix of LIC business: continued growth in pension and annuity business relative to life insurance, and a shift toward interest-rate-sensitive products. Competitive pressures led some LICs to shift their asset portfolios from low- to high-risk investments in order to cover the higher rates on these new liabilities. By the end of the decade, this strategy had begun to unravel. The sudden but short-lived collapse of the junk bond market and the fall in the value of commercial real estate reduced LIC profitability. In reaction, LICs pulled back from the commercial real estate market and certain segments of the corporate bond market.

At first glance, there are many similarities between the savings and loan and the life insurance industries. Both S&Ls and LICs act as financial intermediaries and face substantial government regulation. Life insurance policyholders, like S&L depositors, are protected by government-administered guaranty funds.

Elijah Brewer III is a senior economist with the Federal Reserve Bank of Chicago. Thomas H. Mondschean is assistant professor of economics at DePaul University and consultant to the Economic Research Department of the Federal Reserve Bank of Chicago. Philip E. Strahan is an economist with the Federal Reserve Bank of New York.

Because of the partial guarantee of their liabilities, firms in both industries have incentives to take risk. Many have argued that regulators exacerbated the S&L crisis by allowing thrifts to invest heavily in high-risk loans and securities and by not closing insolvent firms promptly, while private creditors did not impose market discipline on S&Ls because their deposits were guaranteed. Yet despite the similarities between S&Ls and LICs, the life insurance industry has not suffered widespread failures.

In this article we explore possible explanations for the divergence in behavior and performance between these two classes of financial institutions. First, we argue that in contrast to commercial banks and LICs, S&Ls were dangerously exposed to interest rate risk. As a result, when nominal interest rates rose sharply in the late 1970s, S&Ls experienced a larger decline in the market value of their portfolios than did LICs or banks. Then we suggest five key differences that reduced the moral hazard problem for LICs relative to S&Ls:

1) LICs possessed a larger capital cushion than S&Ls;
2) S&L creditors had more confidence in their government guarantees than did LIC creditors;
3) a smaller proportion of LIC liabilities were subject to a government guarantee;
4) LICs were subject to greater market discipline from uninsured creditors; and
5) LICs were subject to greater monitoring by other LICs.

The article is organized into six sections. First, we present financial information about the life insurance industry both to document the importance of LICs as financial intermediaries and to describe the environment in which they operate. Second, we describe the recent financial problems of the industry. Third, we sketch the regulatory framework that protects policyholders and manages insolvencies. Fourth, we discuss how interest rate risk differs across financial institutions. Fifth, we examine key differences that reduced the moral hazard problem for LICs compared to S&Ls. Finally, we discuss the implications of these findings for regulatory policy.

Background

Traditionally, life insurance companies offer customers risk protection by agreeing to indemnify them against losses specified in a policy. Insurance guards against economic loss by compensating those policyholders suffering losses from a pool of funds paid by all policyholders who are exposed to similar risks. At the end of 1991, the most recent year for which data are readily available, over 375 million policies were in force in the United States, with coverage totaling approximately $10 trillion. LICs' total 1991 revenues from premium and investment income were $411 billion.

LICs raise funds primarily from the sale of life insurance policies, annuities, and pension plans that have a savings feature as part of their contract. LICs must set up reserve accounts for the excess of the value of benefits payable in future years over the value of the premiums to be collected for each contract. The reserve accounts are divided into two types of liabilities: (1) life insurance reserves, which cover LIC obligations to policyholders and beneficiaries; and (2) pension reserves, which cover expected payments to retirees and other annuitants. These liabilities of LICs are savings instruments by which households can accumulate wealth for retirement and bequests. In turn, LICs use the premiums paid for these products to invest in debt and equity securities. In doing so, they help transform a large portion of the financial assets of households into real capital investment by businesses and governments.

Premium income from life insurance products represented 44 percent of total gross income of LICs in 1970 but fell to 19 percent by year-end 1991 (see table 1). Much of this decrease occurred because traditional life insurance contracts with savings components offered policyholders a substantially lower return after taxes than did alternative investments. During the 1970s and early 1980s, rising inflation rates and high yields on alternative investments created greater competition for household savings. Returns on traditional life insurance contracts were tied to the average rate of return on the insurer's portfolio. However, because LICs held a large share of fixed-rate bonds purchased previously at lower interest rates, the average rate of return on their portfolio did not increase as rapidly as market rates of interest. As a result, a large gap emerged between prevailing interest rates and the return on traditional LIC contracts. In addition, many policyholders exercised their right to borrow against their policies or cashed them in for their surrender value in order to invest the

TABLE 1

Gross income of life insurance companies
(billions of dollars)

Source of income	1970	1980	1985	1990	1991
Life insurance premiums	21.7 (44.3)[a]	40.8 (31.2)	60.1 (25.7)	76.7 (19.1)	79.3 (19.3)
Annuities[b]	3.7 (7.5)	22.4 (17.1)	53.9 (23.0)	129.1 (32.1)	123.6 (30.1)
Health insurance premiums	11.4 (23.3)	29.4 (22.5)	41.8 (17.9)	58.2 (14.5)	60.9 (14.8)
Investments	10.1 (20.6)	33.9 (25.9)	67.9 (29.0)	111.8 (27.8)	119.0 (28.9)
Other	2.1 (4.3)	4.3 (3.3)	10.2 (4.4)	26.3 (6.5)	28.2 (6.9)
Total	**49.0 (100.0)**	**130.9 (100.0)**	**234.0 (100.0)**	**402.2 (100.0)**	**411.0 (100.0)**

[a]Numbers in parentheses are the percent of total income.
[b]In 1986, there was a large increase in annuity premium receipts because of an NAIC-mandated change in statutory reporting.
Note: Numbers may not add to totals because of rounding.
Source: American Council of Life Insurance.

funds where they could earn higher rates. This created outflows of LIC funds.

To stem outflows and attract additional funds, LICs developed new products such as universal and variable life insurance policies. These differed from traditional whole life policies in that the size of the death benefit and/or the annual premium could change to reflect investment performance over the duration of the policy. Such interest-rate-sensitive products offered new options, including the ability to move the investment portion of the policy among alternative assets to reflect policyholders' current preference between risk and return. As table 1 shows, premium income from annuity business accounted for 30 percent of gross income at the end of 1991, compared with only 7 percent at year-end 1970.

In addition to standard annuity products, some life insurance companies have sold guaranteed investment contracts (GICs). Widely used as funding instruments for defined contribution pension plans, GICs typically obligate an insurance company to repay principal and interest accruing at a predetermined rate in a single payment at maturity. Thus GICs have no insurance element. Competition for this business has resulted in very favorable contract terms for customers, including liberal surrender provisions that allow withdrawals without penalty when promised yields fall below benchmark rates (Cabanilla 1992). Because GICs are relatively short-term liabilities, these contracts tend to reduce the average duration of insurance companies' liabilities. Table 2 reports that the share of life insurance industry general account assets financed by GICs rose from 8.1 percent in 1986 to 10.8 percent in 1990. By year-end 1991, however, this share had fallen to about 8 percent, primarily because some highly publicized failures caused GIC holders to shift funds to alternative investments.

Because the interest income credited on universal life policies and other liabilities affected the demand for these instruments, insurance companies have an incentive to offer high rates during the early years of these policies to attract new customers and to forestall policy lapses and surrenders by existing customers. Wright (1991) claims that in order to maintain the high returns being paid on GICs and other liabilities, many insurance companies sought to increase interest income either by taking on riskier real estate loans or by reducing the quality of their corporate bond portfolios.

Historically, life insurance companies have played an important role in the bond and mortgage markets. In 1960, they held about 50 percent of all outstanding corporate bonds. While

TABLE 2

Guaranteed investment contracts
(billions of dollars)

	Total	Percent of assets
1986	67.1	8.1
1987	74.8	8.0
1988	105.1	10.1
1989	121.6	10.5
1990	134.6	10.8
1991	130.0	8.4

Source: American Council of Life Insurance.

this share has fallen with the growth of mutual funds and pension plans, LICs still hold about one-third of all corporate bonds. Within the bond market, they are major buyers of private placement debt, which are securities issued in the U.S. but not registered with the Securities and Exchange Commission. LICs are also very active in the commercial mortgage market, which provides a market for loans on nonresidential properties such as office buildings and manufacturing plants. Together, LICs, commercial banks, and S&Ls supply about 80 percent of the credit for all commercial real estate loans. During the 1980s, LICs held about 30 percent of all commercial mortgage loans (Cabanilla 1992).

Lending in the private placement and commercial real estate markets requires substantial amounts of information gathering in the form of evaluating credit and monitoring of borrowers' management through covenant enforcement. Recent studies of the private placement and commercial real estate markets have indicated that the loans made by LICs in these markets generally have less uniform terms than do other investments such as publicly traded corporate bonds. As a result, private placements and mortgage loans are less liquid. Yields are higher to reflect information gathering costs and greater default risk. According to data from the American Council of Life Insurance, private placements and mortgage loans represented about 86 percent of new life insurance investments in 1980. At the end of 1991, they accounted for only about 29 percent. Conversely, the share of new funds that LICs invested in publicly traded corporate bonds and mortgage-backed securities has been increasing during the 1980s and early 1990s. In 1980, these assets accounted for about 13 percent of all new investments of LICs. By year-end 1991, that figure had risen to 70 percent. The shift towards marketable and more liquid securities stemmed from the increased securitization of debt as well as from changes in liability structure and from the asset quality problems of life insurers.

Life insurers' emerging financial problems

Table 3 examines the financial characteristics of LICs classified by their 1986 book value statutory capital-asset ratios. More than three-quarters of the industry's assets were held by LICs with capital and surplus less than 9 percent of general account assets (low-capital LICs)[3]. Low-capital LICs held greater proportions of mortgage loans and junk bonds than did companies with capital ratios above 9 percent (high-capital LICs). Guaranteed investment contracts are a relatively more important funding source for low-capital LICs than for high-capital companies. Figure 1 presents the market capitalization-asset ratios for a sample of 44 publicly traded life insurance companies classified as "high" junk bond holders (9), "high" commercial mortgage loan holders (11), and "others" (24).[4] All three groups of LICs experienced a deterioration in market capitalization over the 1986-1990 sample period. However, the deterioration was the greatest for the high junk bond holders. Other things held constant, lower market capitalization-asset ratios at high junk bond LICs indicate a greater exposure to the risk of failure.

During the late 1980s and early 1990s, the increased emphasis on nontraditional insurance products along with shifts towards ex ante riskier assets took its toll. Declines in the market values of below-investment-grade bonds and commercial real estate reduced the market value of capital of many LICs; a few have been rendered insolvent. Two announcements in 1990 highlighted the industry's emerging financial difficulties. In January, First Executive Corporation, a large holder of below-investment-grade bonds, announced that it would take a charge of $515 million in the fourth quarter for junk bond losses. Then in October, Travelers Corporation, one of the largest holders of commercial real estate loans, announced it was setting aside $650 million in reserves for anticipated losses on its commercial real estate portfolio. These and similar problems at other LICs led to policyholder liquidity runs and the collapse of several large companies such as First Executive Corporation in mid-1991. Liquidity runs could occur because many of the new products sold by LICs provide policyholders with liberal withdrawal provisions in which the holder may demand immediate payment of principal and accrued interest. According to Fenn and Cole (1992), holders of GICs and other interest-rate-sensitive products are more likely than traditional policyholders to exercise withdrawal options on annuity products and to borrow against insurance products when the issuing firm appears troubled. Surviving LICs have responded to these financial problems by reducing their holdings of risky assets and improving capital ratios.

The weakened condition of LICs reduced the supply of credit in both the commercial mortgage market and the below-investment-grade segment

TABLE 3

Financial characteristics of life insurance companies
(billions of dollars)

High-capital companies[a]	1986	1987	1988	1989	1990
			billions of dollars		
Mortgage loans	22.3	24.4	26.7	30.1	32.2
Junk bonds	4.7	6.7	5.6	6.8	7.7
GICs	2.3	3.4	5.3	10.2	13.8
Total general account assets	**179.7**	**201.2**	**229.7**	**259.0**	**290.5**
			percent		
Book value of net worth/ mortgage loans	163.8	157.4	153.9	148.8	144.4
Book value of net worth/ junk bonds	783.8	572.6	739.0	659.0	606.3
Book value of net worth/ total assets	20.3	19.1	17.9	17.3	16.0
Low-capital companies[a]	**1986**	**1987**	**1988**	**1989**	**1990**
			billions of dollars		
Mortgage loans	173.1	193.5	211.2	229.5	242.6
Junk bonds	28.9	40.3	38.9	44.7	43.3
GICs	67.6	82.4	95.7	110.0	117.7
Total general account assets	**683.6**	**757.1**	**842.1**	**918.2**	**979.1**
			percent		
Book value of net worth/ mortgage loans	16.7	16.5	17.2	18.1	19.3
Book value of net worth/ junk bonds	100.8	79.0	93.2	93.3	108.5
Book value of net worth/ total assets	4.2	4.2	4.3	4.5	4.8

[a]Low-capital life insurance companies are those with book capital-asset ratios less than or equal to 9 percent at the end of 1986. The remaining companies are classified as high-capital.

Source: National Association of Insurance Commissioners (NAIC), Database of Annual Statements.

of the private placement market. Carey, *et al.* (1992) show that in the below-investment-grade segment of the private placement market, loan volume was down and loan rates were up. The rise in rates was not caused by a general increase in loan risk, but rather by LICs' flight to quality. Corcoran (1992) also concludes that the reduced willingness of insurance companies to make new loans exacerbated the credit problems of the recent recession. The deterioration of commercial real estate values and an increase in mortgage delinquency rates, as illustrated in figure 2, led LICs to reduce their exposure to both commercial real estate as well as the private placement market.

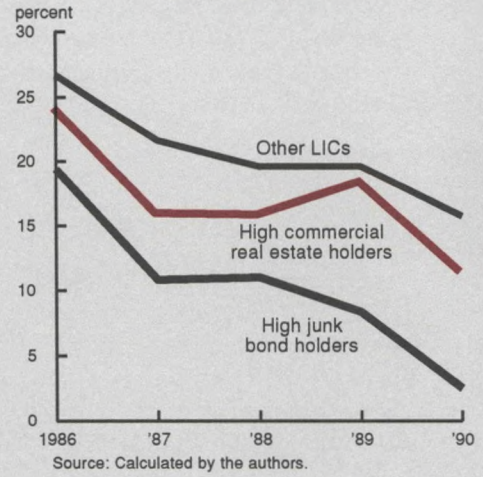
As a result of these problems, the industry capital-asset ratio fell in 1990 to 8.5 percent. In 1991, the life insurance industry increased its capital-general account asset ratio to 9.3 percent, signalling an improved ability of firms to absorb losses without becoming insolvent. This cushion should help reassure policyholders about the solvency of LICs.

Regulation of life insurance companies

Just as a capital cushion protects policyholders and other creditors from losses at LICs, government regulation also safeguards their interests. Life insurance companies are regulated for many of the same reasons as are other

FIGURE 1

Market capitalization of some LICs



Source: Calculated by the authors.

financial intermediaries: first, to offset the moral hazard problems exacerbated by government guarantees of LICs' liabilities; second, to decrease the probability that failure of one LIC may cause policyholders at other LICs to exercise their surrender options after losing confidence in their companies' ability to meet obligations;[5] and third, to protect taxpayers from losses resulting from LIC failures.

State insurance departments are the agencies charged with regulating LICs. State regulators enforce rates, asset restrictions, and other policies established by state legislation. If a company wishes to write insurance in a particular state, it must first receive permission from the state insurance commissioner. Thereafter, LICs must provide regulators with income statement and balance sheet information annually. In addition, state insurance departments usually audit companies operating within their borders once every three years. Most states levy a tax on insurance premiums to finance part of the cost of regulation. The National Association of Insurance Commissioners (NAIC) also monitors LICs by performing annual computerized audits. Companies failing four or more of eleven NAIC audit ratio tests face increased monitoring from state regulators (see Cummins 1988 for more details).

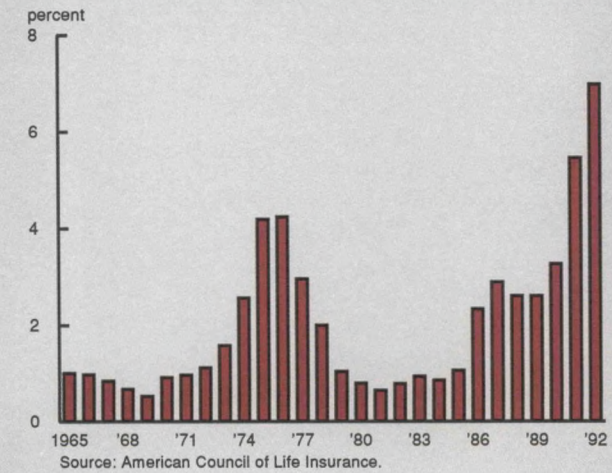
Despite the uniform standards proposed by the NAIC, life insurance companies are still subject to widely varying degrees of regulatory scrutiny. Examinations vary with the size and sophistication of state insurance departments or with the level of resources that states allocate to regulation. Further, LICs vary in their ability to lobby for less restrictive regulations or scrutiny, and states vary in their susceptibility to such pressures.

To protect policyholders and to manage insolvencies, all fifty states and the District of Columbia have established guaranty funds. Prior to 1970, only one state had a guaranty system to cover the obligations of life and health insurance companies. Then in 1970, the NAIC adopted a "model" guaranty system for subsequent consideration by individual state legislatures. In addition to provisions stating what the guaranty fund covered, the NAIC model also allowed insurance companies to credit guaranty fund assessment costs on their state premium taxes. Within a year, nine states adopted legislation based on or similar to the NAIC model. Guaranty systems satisfy benefit claims of policyholders and annuitants in the event that an insolvent company lacks sufficient assets after liquidation. Harrington (1991) claims that the growth of these guaranty funds has contributed to the increased number and magnitude of insolvencies in the insurance industry in recent years.

Guaranty funds are financed by ex post assessments on surviving insurance firms operating in the particular state, with each company

FIGURE 2

Delinquency rates of commercial real estate mortgages



Source: American Council of Life Insurance.

paying an assessment based on its share of total premium income. As of December 31, 1992, in 39 states, LICs may offset assessments against their state taxes, thereby shifting the cost of failure directly onto state taxpayers. In the remaining states, LICs may impose a premium surcharge to cover the cost of the assessment.

In most states, coverage under guaranty funds is $300,000 in death benefits, $100,000 in cash or withdrawal value for life insurance, $100,000 in present value of annuity benefits, and $100,000 in health benefits. Some states cover all insurance policies written by an insolvent firm located in the state; others cover the policies of residents only. In the case of unallocated annuities such as GICs purchased by companies to fund pension plans, some states cover up to a certain amount, usually $5 million. Other states, such as California, Massachusetts, and Missouri, do not cover GICs.

Because of variations in state guaranty funds and in the way insolvencies are handled, the parties bearing the costs of an insurance failure differ across states. Surviving insurance companies initially pay their assessments and claim them as an expense on their federal corporate income tax return, reducing their federal income taxes. As companies receive tax credits in subsequent years, these credits become taxable income. As a result, the federal government bears part of the cost of an insolvency since it does not fully recover the present value of the tax decrease granted in the assessment year. In states with premium tax offsets, however, the majority of the cost is paid by state taxpayers. A study of 1990 life/health guaranty fund assessments found that 73.6 percent was paid by state taxpayers, 8.9 percent by federal taxpayers, and 17.5 percent by the equity holders of the surviving firms.[6]

The way in which state guaranty systems manage insolvencies raises several policy concerns. First, LICs pay nothing ex ante to receive the guarantees. Assessments are based on the ex post cost of a given failure and bear no relationship to current or future LIC risk exposure. Second, companies in states with premium tax offsets have little incentive to monitor each other, since over 80 percent of the assessment will be recouped through lower taxes. Third, insurance guaranty funds reduce the incentive for policyholders to exercise market discipline. In the absence of guaranty funds, policyholders would have more incentive to buy from safe LICs or to demand lower premiums from high-risk firms. As the S&L crisis demonstrated, government guarantees of firm liabilities could create a moral hazard problem. If these guarantees are mispriced, institutions with low net worth may have strong incentives to gamble for resurrection by investing in riskier assets.[7]

Interest rate risk at financial institutions

The value of LIC portfolios has traditionally been relatively insensitive to changes in interest rates.[8] A large proportion of LICs' liabilities consists of life insurance reserves, and most of the payments for these products occur in the distant future. Most LIC assets consist of long-term corporate debt, mortgages, and long-term government securities. In the absence of credit risk, both the nominal death benefits and the payoff of these long-term assets are determined at the outset. As a result, the firm is less exposed to unanticipated changes in interest rates. If the firm decides to hold short-term assets such as Treasury bills or commercial paper against life insurance policies, it would have no guarantee that its portfolio could support future claims. Declines in interest rates would reduce the firm's earnings and its ability to meet future obligations.

Regulation of savings institutions, on the other hand, has encouraged these firms to hold long-term, fixed-rate mortgage loans financed with short-term deposits. This strategy worked well during the period of stable interest rates from the end of World War II to the 1960s. But S&Ls remained vulnerable to changes in the level of interest rates. Because of Regulation Q interest rate ceilings, S&Ls were prevented from offering depositors competitive rates when market interest rates rose above the ceiling rate. When this occurred, many depositors withdrew their funds in order to invest them in higher-yielding money market instruments, which caused outflows of S&L deposits. To stem the outflow, S&Ls were allowed to offer several deposit products not subject to Regulation Q ceilings. However, because over 80 percent of S&L assets were invested in long-term, fixed-rate mortgage loans made previously at lower rates, their interest income did not increase as rapidly as their cost of funds. As a result, S&Ls suffered negative interest rate margins. This predicament—interest rate risk—is particularly characteristic of the S&L industry. Figure 3

compares the capital-asset ratios for the S&L and life insurance industries. Between 1978 and 1982, the S&L capital ratio fell from 5.6 to 0.6 percent but the LIC capital ratio actually rose from 8.3 to 9.1. Since there is a better correspondence between the durations of assets and liabilities of LICs, these institutions were less exposed to interest rate risk; hence, they did not experience the large losses and subsequent declines in capital as a result of high nominal interest rates from 1978 to 1982.

To judge a firm's exposure to interest rate risk, we use stock market data. The stock returns of financial institutions depend on many economic variables besides interest rates, such as expectations of future economic conditions, future investment opportunities, productivity, and tax policies. Using a two-factor market model from the finance literature, we relate the return on a portfolio of each type of institution to the return on an index of the overall stock market and the return on a portfolio of long-term government securities. The following equation allows us to compare the relative exposure of the three types of financial institutions to interest rate risk:

$$(1)\quad R_{j,t} = \alpha_j + \beta_{M,j} R_{M,t} + \beta_{I,j} R_{I,t} + \varepsilon_{j,t}$$

where

$R_{j,t}$ = return on financial institution j at t,

$R_{M,t}$ = return on stock market,

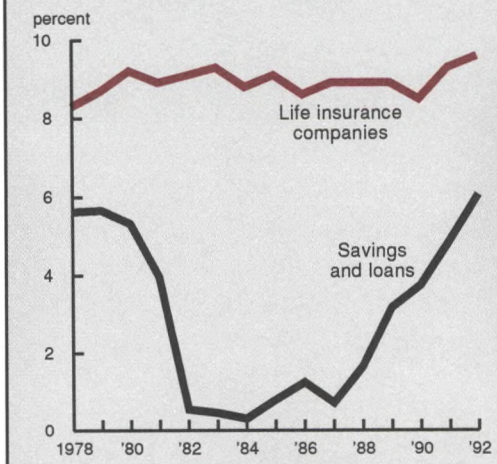
$R_{I,t}$ = return on portfolio of long-term government bonds.

The variable $R_{M,t}$ controls for all economic variables that would affect profits for all corporations. The value of the second variable, $R_{I,t}$, depends solely on interest rates, so its coefficient provides an estimate of the interest rate sensitivity of each type of financial institution.

We estimated equation 1 using monthly returns for two sample periods, 1972-1982 and 1983-1991. We split the sample at the end of 1982 for several reasons. During the first period, S&Ls and banks faced government-mandated interest rate ceilings. After the passage of the Depository Institutions Deregulation and Monetary Control Act of 1980, these regulations began to be phased out. Moreover, the Garn-St Germain Depository Institutions Act of 1982 substantially liberalized S&L asset-holding

FIGURE 3

Capital-asset ratios



Note: The measures of capital used are statutory capital for LICs and tangible capital for S&Ls.

Sources: American Council of Life Insurance and Office of Thrift Supervision.

powers. Both of these laws allowed S&Ls to reduce interest rate risk. Also, the market value of S&L capital dropped sharply during the 1981-1982 period. Brickley and James (1986) show that stock returns for poorly capitalized firms may respond less to economic variables since the deposit insurer bears the brunt of all losses.

The results of estimating equation 1 appear in table 4. They show that S&Ls were much more exposed to interest rate fluctuations than either banks or LICs. In the first sample period, for instance, interest rate changes did not significantly influence the stock returns of LICs. By contrast, S&L stock returns were highly sensitive to those changes. For example, the estimated coefficient shows that S&L stock returns exhibited 90 percent as much sensitivity to interest rate changes as did a portfolio of twenty-year government bonds. In fact, one cannot reject the null hypothesis that during the 1972-1982 period, S&L stock prices were as sensitive to interest rates as were long-term government bond prices.

Flannery and James (1984) show that the degree of sensitivity of bank stock returns to interest rates depends directly on the duration mismatch between its assets and liabilities. Since life insurance companies actively try to match the maturity of both sides of their balance sheet, it is not surprising that LIC stock returns exhibit little interest rate sensitivity.

In the second sample period, the interest rate sensitivity of S&L stocks decreased from

TABLE 4

Estimates of interest rate sensitivity for portfolios of commercial bank, savings and loan, and life insurance stocks[a]

Industry	Intercept	Return on market portfolio	Return on government bond portfolio	$\bar{R}^2$	Durbin-Watson statistic
1972-1982					
Savings and loans	-0.003 (0.004)[b]	1.030* (0.066)	0.904* (0.128)	75.4%	2.185
Commercial banks	0.001 (0.002)	0.510* (0.029)	0.150* (0.056)	75.4%	1.866
Life insurance	0.001 (0.002)	0.707* (0.030)	0.074 (0.057)	84.0%	1.819
1983-1991					
Savings and loans	-0.010 (0.004)	0.996* (0.077)	0.484* (0.125)	65.6%	1.622
Commercial banks	0.003 (0.003)	0.662* (0.046)	0.154 (0.075)	67.8%	1.378
Life insurance	0.002 (0.002)	0.722* (0.038)	0.164* (0.062)	79.1%	1.618

[a]The monthly portfolio of returns for each industry includes all publicly traded stocks on the New York and American Stock Exchanges and the NASDAQ. The data are from the Center for Research in Securities Prices (CRSP). The market index is the monthly return on an equally weighted portfolio of all stocks on the three exchanges, inclusive of dividends. The interest rate index is the monthly return on a portfolio of long-term government bonds with maturity of approximately 20 years. These two indices are also from CRSP.

[b]Standard errors appear in parentheses.

*significant at the .01 level.

0.90 to 0.48, while neither the bank nor the LIC interest rate sensitivity changed significantly from the first sample period. Evidently, the deregulation the S&L industry may have had the intended effect of reducing but not eliminating interest rate risk. However, with S&L industry capital at historic lows during this period, the lack of responsiveness of stock returns to interest rate volatility may reflect the put protection afforded by deposit insurance. As a firm's capital approaches zero, further declines will be reflected in increased deposit insurer liability rather than in stock returns. Since the capital of LICs and banks did not fall to the same degree in the 1980s, those institutions apparently did not experience a similar decline in interest rate sensitivity. In fact, for LICs the point estimate actually increases from 0.07 to 0.16, although this difference is not statistically significant.

These results indicate that S&Ls were uniquely vulnerable to interest rate movements in the 1970s. We attribute the weakness of this industry to regulations that encouraged savings institutions to hold an unbalanced book. In contrast, both LICs and commercial banks have been permitted to hold a sufficiently broad array of assets to facilitate better diversification.

Moral hazard at financial institutions

Insurers have long dealt with moral hazard. By its very nature, insurance reduces the costs associated with a particular bad outcome and thus weakens the purchaser's incentive to take costly self protective actions. For instance, holders of fire insurance have less incentive to buy fire extinguishers to protect their property than do uninsured individuals. In private markets, one way in which insurers mitigate this problem is by adding deductibles and copayments to policies. In the case of financial institutions, government liability guarantees weaken the incentive for creditors to discipline the propensity of firms to bear additional risk; fully insured depositors with confidence in the Federal Deposit Insurance Corporation (FDIC) will not waste time monitoring their banks' investment decisions. Effective monitoring by regulators and/or other firms can mitigate this moral hazard problem.

Many analysts have argued that the S&L crisis occurred because government regulators did not control the moral hazard inherent in fixed-premium deposit insurance.[9] Regulatory oversight declined during the 1980s. Insolvent S&Ls that were permitted to remain in operation were not monitored very closely. In addition, S&Ls were given new rights to invest in high-risk assets such as junk bonds and acquisition and development loans. In pursuit of high profits, many S&Ls responded by collecting federally insured deposits and investing them in high-risk, high-expected-return assets. This action deepened the insolvency problems. As a result, between 1987 and 1992 over 800 S&Ls were resolved by the Federal Savings and Loan Insurance Corporation (FSLIC) and later the Resolution Trust Corporation.

Brewer and Mondschean (1993b) show empirically that life insurance companies face similar moral hazard problems. They found that over the 1986-90 period, low-capital LICs experienced one-time increases in market value capital following a shift from low-risk assets to high-risk assets such as real estate direct investment and equity issues. As expected, increases in risky assets did not have a statistically significant effect on the market value of high-capital LICs.

Brewer and Mondschean (1993c) also show that the largest LICs that failed in 1991 had sizable exposures to junk bonds. In fact, their exposure was so large that a decline of 12 to 14 percent in the value of their junk bond portfolio was sufficient to wipe out their book capital completely. These findings are consistent with a moral hazard problem associated with government liability insurance.

In response to declining asset values, both LICs and S&Ls were forced to set aside funds to reserve against losses on securities and loans. However, regulators anticipate spending over $200 billion of taxpayers' money to resolve the S&L debacle, while the cost of managing insolvent LICs should be much less. We suggest that five key differences between the environment in which LICs operated relative to S&Ls reduced the moral hazard problem sufficiently to prevent a crisis in the life insurance industry.

Vulnerability to capital shocks

S&Ls faced a massive capital shock when interest rates skyrocketed in the early 1980s. In addition, regulators lowered the minimum capital requirements all S&Ls had to meet. Neither banks nor LICs faced a comparable decline in net worth.

As capital declines or capital forbearance grows, a firm has an increasing incentive to pursue an aggressive strategy. This is because the firm's capital acts as a deductible payment in a traditional insurance arrangement. In this context, the chance of losing the value of the owners' stake in the firm reduces the incentive to hold risky assets.[10] A firm with little or no capital, however, has little or nothing to lose by pursuing a gambling strategy. This explains why many insolvent S&Ls invested heavily in junk bonds during the 1980s. If the investments paid off, the institution's owners reaped the rewards; if the returns were low, the losses were passed on to the deposit insurer.

Figure 3 compares S&L and LIC book value capital ratios from 1975 to 1991. LIC capital ratios fluctuated between 8.0 and 9.3 percent over the period but exhibited little trend. By contrast, S&L capital ratios, computed using tangible accounting principles, fell sharply after the 1979-1982 recession. Since S&Ls are more exposed to interest rate changes than banks or LICs, they suffered massive losses when interest rates rose in the late 1970s and early 1980s. This capital shock exacerbated the moral hazard problem.

Federal versus state guarantees

S&Ls' guarantees are administered by the federal government and carry the implicit backing of the U.S. Treasury. This fact is widely known and inspires near-universal confidence. By contrast, LICs' guarantees are administered by their respective states and carry no comparable backing. These guarantees are not as well publicized as federal deposit insurance and seem to inspire less confidence in policyholders. As a result, insurance companies are more sensitive to the impact of poor financial health and asset risk on their ability to raise funds.

Three cases from the life insurance industry support this interpretation. Mutual Benefit of New Jersey, like other LICs in that state, had no government guarantee on its liabilties. In early 1991, the company's asset quality problems led its GIC holders to surrender their contracts. The asset writedowns at First Executive Corporation in early 1990 were followed by policyholder liquidity runs at its life insurance subsidiaries in New York and California. Apparently lacking faith in the guaranty fund system, policyholders

increased their surrender requests from the New York subsidiary after the regulatory seizure of First Executive Corporation's California unit in April 1991. Another New York example is the case of Mutual Life Insurance Company of New York (MONY). Despite the existence of a guaranty fund, policy and contract holders withdrew more than $900 million during the third quarter of 1990, reflecting concern about MONY's large real estate exposure. Similar liquidity runs occurred at S&Ls in Ohio and Maryland that were covered by state deposit insurance funds.

No such panic has occurred in federally insured S&Ls. Depositor confidence in the FSLIC, or at least in the implicit backing of the U.S. Treasury, has remained sufficiently high to prevent runs.[11]

Breadth of coverage

Because of the breadth of de facto coverage, S&Ls are able to use fully insured deposits as their primary source of funds. Congress increased deposit insurance coverage in 1981 to $100,000 per depositor per institution. Moreover, all uninsured depositors have received full reimbursement in resolutions not culminating in liquidation. Some of the asset growth by S&Ls in the 1980s was financed by brokered deposits. These funds allowed S&Ls to draw deposits from the national market without giving up the benefit of federal deposit insurance coverage.

By contrast, while some LICs used GICs and single premium deferred annuities (SPDAs) during the 1980s to facilitate growth, these instruments have not received the same level of government backing as did brokered S&L deposits.[12] In several cases, failure resolutions have imposed losses on LIC creditors in the form of delays in repayment and loss of interest. Unlike traditional life insurance products, GICs and SPDAs could be put back to the company at face value. This fact helps explain why the run on Mutual Benefit of New Jersey was started by GIC holders.

Monitoring

Financial institutions may face losses as a result of the failure of a competing institution. In the deposit insurance system, all banks and S&Ls pay upfront for deposit insurance. LIC state guaranty funds make these losses explicit in that surviving LICs pay the costs of a resolution. LICs can reduce these costs by pressuring regulators to tighten enforcement of safety and soundness regulations. In some states, LICs can also pass resolution costs on to taxpayers through premium tax credits. Brewer, Mondschean, and Strahan (1992) found that in states where premium tax credits do not exist, LICs hold safer portfolios. This is strong evidence that when guaranty systems provide incentives for self-monitoring, they reduce risk-taking and increase industry stability. Calomiris (1989) reached a similar conclusion in his study of antebellum deposit insurance systems. He found that self-regulating mutual liability systems achieved stability and survived financial panics.

Free rider problems

The size of a government insurance fund may also influence the behavior of its members. Larger systems will face greater free rider problems, which lead to less monitoring and weaker enforcement of regulations. As noted earlier, in state guaranty systems, surviving firms pay the costs in the event of failure. In the federal deposit insurance system, taxpayers provide financial backing, yet member institutions also bear some of the costs associated with widespread failures. In fact, the FDIC tripled its fees in the aftermath of the FSLIC's bankruptcy and the deterioration of the reserves in the Bank Insurance Fund. Thus in both systems, firms have an incentive to reduce the costs associated with these government guarantees. But individual firms have more at stake in smaller, state-administered life insurance guaranty funds. As a result, LICs have a greater incentive to pressure regulators to enforce constraints on high-risk behavior.[13]

Conclusions and policy prescriptions

The recent failures of several large insurance companies have raised concerns about the soundness of the life insurance industry. The industry's overall portfolio risk appears to have increased during the 1980s. Moreover, LICs with lower capital ratios have higher concentrations of junk bonds and commercial real estate than do well-capitalized LICs. In response to the liquidity runs in the early 1990s, the life insurance industry has restored profitability and raised new capital. The experiences of the life insurance industry stand in stark contrast to the disastrous problems that S&Ls experienced and suggest some conclusions about how to contain risk-taking of depository institutions.

Like S&Ls and banks, life insurance companies may succumb to moral hazard because government guarantees weaken the incentive for creditors to constrain firm risk-taking. Our research indicates that the use of premium tax

offsets for guaranty fund assessments encourages LICs to increase portfolio risk. In addition, concerns about liquidity runs have caused LICs to reduce their holdings of risky assets and improve capital ratios. These findings suggest a number of policy prescriptions that could help improve the safety and soundness of the life insurance industry. First, since government backing makes life insurance policies more attractive, LICs should pay for access to the guarantees. Premium tax offsets for the costs of resolving failures tend to lead to less industry monitoring because surviving LICs can pass a larger portion of the costs of resolving failures onto taxpayers. These offsets should be eliminated. Finally, regulators could increase market discipline by encouraging LICs to finance a portion of their assets with puttable, uninsured liabilities such as guaranteed investment contracts.

Despite these weaknesses in the regulatory structure of LICs, it also contains strengths that should be extended where possible to depository institutions. For instance, risk-taking may be contained by encouraging financial institutions to monitor each other and thus reduce the need for costly regulation. What is crucial is aligning the incentives of taxpayers and financial institutions to reduce the cost of government guarantees. We believe that state guaranty funds create fewer incentive problems than does deposit insurance because they encourage self-monitoring to minimize the potential costs of LIC failures. The behavior of financial institutions also may be more effectively controlled by complementing regulatory oversight with market discipline. Discipline could be imposed by a specific class of creditors which is willing to monitor financial institution risk and bear the risk of loss.

The FDIC Improvement Act of 1991 (FDICIA) extends some of the features that exist in the LIC industry to depository institutions. The act improves monitoring with the requirement that all depository institutions, regardless of size, that are determined to have insufficient capital must be closed, recapitalized, or otherwise restructured. These provisions for prompt corrective action allow bank regulatory agencies to intervene early and thus reduce the exposure of the deposit insurance fund to losses. Other provisions of the act authorize the FDIC to implement a system of risk-based deposit insurance with premiums related, in part, to the cost of future bank failures. Thus banks have greater incentives to monitor each other to keep deposit insurance assessments down. As the experience of the life insurance industry has indicated, private monitoring can reduce the cost of government guarantees.

FOOTNOTES

[1]See Resolution Trust Corporation (1993).

[2]The term *life insurance company* refers throughout this article to firms classified as life and/or life-health insurance companies.

[3]General account assets equals total assets minus separate account assets. Separate accounts are defined as groups of assets designed as backing for specific obligations in which the investment risk is borne by the policyholder, and the insurer's guarantee is limited to mortality and expense charges (see Saunders 1986).

[4]To be considered a "high" junk bondholder, an LIC in our sample must have a junk bond-asset ratio of 6.6 percent, the industry average at year-end 1990. The remaining LICs were classified as "high" commercial mortgage loan holders if their commercial loan-asset ratio was greater than or equal to 21.6 percent, the industry-wide average at the end of 1990. The rest were classified as "others."

[5]Fenn and Cole (1992) analyze the impact of policyholder behavior on the market value of insurance companies in the event of an insolvency.

[6]See Barrese and Nelson (1992).

[7]Harrington (1991) makes this point for property-casualty companies, which also benefit from state guaranty funds.

[8]LICs were not immune to the effects of high interest rates. Because insurance policyholders had incentives to take out policy loans at below-market interest rates, LICs suffered from disintermediation. (Curry and Warshawsky 1986).

[9]See Kane (1989) for a discussion of the theory of moral hazard as applied to S&Ls. For empirical evidence on the subject, see Brewer and Mondschean (1993a) and Barth, Bartholomew, and Labich (1989).

[10]See Furlong and Keeley (1989) for an analytical derivation of this result.

[11]There is some evidence of a loss of confidence in FSLIC insurance. Both Brewer and Mondschean (1992) and Strahan (1993) show that weak S&Ls paid higher rates for both wholesale and retail deposits than did well-capitalized institutions. Moreover, Strahan shows that weak S&Ls that did not raise their rates faced deposit outflows.

[12]Todd and Wallace (1992) detail the growth of GICs and SPDAs during the 1980s.

[13]These free rider problems may be contained by organizations such as the Community and Savings Banks of America and the American Bankers Association.

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