**Efficiency, Scale Economies, and Consolidation**
**In the U.S. Life Insurance Industry**

By

J. David Cummins
The Wharton School
University of Pennsylvania

Sharon Tennyson
The Wharton School
University of Pennsylvania

and

Mary A. Weiss
Temple University

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J. David Cummins*
Wharton School
3641 Locust Walk
Philadelphia, PA 19104-6218
Phone: 215-898-5644
Fax: 215-898-0310

Sharon L. Tennyson
Wharton School
3641 Locust Walk
Philadelphia, PA 19104-6218
215-898-9811
215-898-0310

Mary A. Weiss
Temple University
Ritter Hall Annex
Room 479 (004-00)
Philadelphia, PA 19122
215-204-1916
215-204-4712

*Corresponding author.

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## Abstract

This paper examines the relationship between mergers and acquisitions, efficiency, and scale economies in the US life insurance industry. We estimate cost and revenue efficiency for life insurers representing 80 percent of industry assets over the period 1988-1995 using data envelopment analysis (DEA) and decompose cost efficiency into pure technical, scale, and allocative efficiency. The Malmquist index methodology is used to measure changes in efficiency and productivity over time. The results support the hypothesis that acquired firms achieve greater efficiency gains than firms that have not engaged in merger or acquisition activity. We also find evidence that firms operating with non-decreasing returns to scale are more likely to be acquisition targets than firms operating with decreasing returns to scale. Firms with higher revenue efficiency are more likely to be acquired than firms with lower revenue efficiency, but we find no relationship between other types of efficiency and the probability that a firm is acquired. Financially vulnerable firms are more likely to be acquired than stronger firms. The overall conclusion is that mergers and acquisitions in the life insurance industry appear to be driven for the most part by economically sound objectives and have had a beneficial effect on efficiency in the industry.

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### 1. Introduction

During the past decade, the U.S. life insurance industry has experienced an unprecedented wave of mergers and acquisitions. Traditionally, the industry has been known for its high-cost distribution system and lack of price competition, but insurers are increasingly faced with more intensive competition from non-traditional sources such as banks, mutual funds, and investment advisory firms. These non-traditional competitors have captured a major share of the market for asset accumulation products such as annuities and cash value life insurance.[1] The increased competition has narrowed profit margins and motivated insurers to seek ways to reduce costs. The adoption of more stringent solvency standards under the risk-based capital system adopted in 1993 also has put pressure on insurers to strengthen their financial statements. Technological advances in the systems used for sales, pricing, underwriting, and policyholder services have forced insurers to become more innovative; and the relatively high fixed costs of the new systems may have affected the minimum efficient scale in the industry.

These developments suggest that scale economies and potential efficiency gains may provide a major motivation for the recent mergers and acquisitions in the insurance industry.[2] Indeed, insurers often cite efficiency and scale economies in justifying mergers and acquisitions to regulators. Thus, an important issue in insurance industry consolidation is whether mergers and acquisitions actually succeed in improving efficiency. We investigate this issue by measuring cost efficiency and scale economies in the U.S. life insurance industry over the period 1988-1995, using data envelopment analysis (DEA) (see Charnes, et al., 1994). Our analysis focuses on acquisition targets: We compare the efficiency and scale economies of targets of mergers and acquisitions with firms that have not been targets of consolidation activity. We analyze mergers and acquisitions over the period 1989-1994, to allow at least one year before and after the event year to study performance. The Malmquist index approach is used to measure changes in efficiency and productivity over time (see Grosskopf, 1993). All U.S. life insurers with usable data are included in our analysis.

In spite of the magnitude and importance of the consolidation trend in the life insurance industry, no prior research on the topic exists. Thus, ours is the first paper to investigate the effects of life insurer mergers and acquisitions on efficiency and scale economies. There have been several prior papers on the efficiency of U.S. life insurers.[3] Grace and Timme (1992) estimate cost economies in the U.S. life insurance industry using data from 1987 and conclude that the majority of firms in the industry exhibit significant economies of scale. Yuengert (1993) estimates cost efficiency for a sample of life insurers using data from 1989. He finds evidence of ray scale economies in the industry but finds no evidence of product mix economies. Gardner and Grace (1993) estimate efficiency in the life insurance industry over the period 1985-1990 and find that the stringency of the regulatory environment affects efficiency. Finally, Cummins and Zi (1998) estimate scale economies in the industry over the period 1988-1992. They find that the majority of firms with more than $1 billion of assets exhibit decreasing returns to scale, while the majority of smaller firms exhibit either increasing or constant returns to scale. There have been only a few prior papers on mergers and acquisitions in the U.S. insurance industry (BarNiv and Hathorn, 1997; Chamberlain and Tennyson, 1997; Meador, Madden and Johnston, 1986). These papers all examine mergers in the property-liability insurance industry, and do not consider issues related to efficiency or economies of scale.

The paper proceeds as follows. Section 2 discusses various hypotheses that have been proposed regarding firms' motivations for mergers and acquisitions, and specifies the hypotheses to be investigated in this paper. Section 3 presents an empirical overview of concentration trends in the life insurance industry. Section 4 discusses our procedures for identifying life insurance acquisitions, and presents summary statistics on mergers and acquisitions in the industry. Our data base and methodology for the efficiency analysis are discussed in section 5. Section 6 presents our estimates of efficiency and scale economies, and section 7 concludes.

## 2. Hypothesis Formulation

In this paper, we investigate both cost and revenue efficiency. Cost efficiency for a specific firm is defined as the ratio of the costs of a fully efficient firm with the same output quantities and input prices (i.e., a firm operating on the efficient cost frontier) to the given firm's actual costs. Cost efficiency varies between zero and 1, with fully efficient firms having cost efficiency equal to 1. One minus a firm's efficiency ratio provides a measures of the proportion by which costs could be reduced if the firm were operating on the cost frontier. Firms achieve cost efficiency by adopting the best practice technology (becoming *technologically* efficient) and by adopting the optimal mix of inputs (becoming *allocatively* efficient), holding constant outputs and input prices. Revenue efficiency is defined as the ratio of a given firm's revenues to the revenues of a fully efficient firm with the same input quantities and output prices. Fully efficient firms have revenue efficiency equal to 1 while inefficient firms have revenue efficiency less than 1. Revenue efficiency is attained by employing the best practice technology and choosing the optimal mix of outputs, holding constant input quantities and output prices.[4] Because most of the hypotheses discussed below apply to both cost efficiency and revenue efficiency, references to efficiency are to be understood to apply to both types of efficiency unless otherwise stated.

The quest for scale economies is often given as the rationale for mergers and acquisitions. Thus, firms operating with non-decreasing (increasing or constant) returns to scale are likely to be viewed as attractive acquisition targets because they are currently operating in the optimal size range (in the case of constant returns to scale) or have the opportunity to become more efficient through growth (in the case of increasing returns to scale). On the other hand, firms operating with decreasing returns to scale are likely to be viewed as unattractive acquisition targets because they are already "too large" in terms of scale economies and would have to be reduced in size to achieve optimum scale.[5] Thus, we hypothesize that acquisition targets are more likely than firms not engaging in mergers and consolidation activity (non-

M&A firms) to be characterized by non-decreasing (increasing or constant) returns to scale.[6]

Another objective frequently given for mergers and acquisitions is to increase market share in a firm's core lines of business or to diversify into new markets either in terms of product offerings or geographical regions. Under this objective as well, firms characterized by non-decreasing returns to scale would seem to be more attractive as acquisition targets or merger partners than those in the decreasing returns to scale range because future growth is less likely to have adverse economic consequences for firm in the non-decreasing returns to scale range.

Mergers may also be motivated by opportunities to improve firm operating performance; in such circumstances a merger or acquisition may be expected to enhance the efficiency of the target firm and/or the combined post-merger entity. There are a number of reasons to believe that mergers and acquisitions can permit insurance firms to operate more efficiently. The predominant organizational model in the insurance industry is the insurance group, consisting of several insurers under common ownership.[7] Adding an unaffiliated firm or a member of a less efficient group to a relatively efficient group has the potential to improve efficiency. Members of groups often operate independently in terms of marketing, either specializing by product line or geographical region. However, a number of important operations such as information systems, investments, and policyholder services are usually conducted centrally. Spreading the fixed costs of these operations over a broader base has the potential to improve cost efficiency. Revenue efficiency may be improved as well if consolidation facilitates cross-selling, improves customer satisfaction, and otherwise enhances the firm's ability to produce revenues. If the managers of acquiring firms are more capable than those of acquirers, one would also expect to observe efficiency gains following a merger or acquisition. Accordingly, we hypothesize that the efficiency of target firms will tend to increase following an acquisition.

Opportunities for post-merger performance improvements may be greater in firms that are currently relatively inefficient. This reasoning would imply that life insurance targets should exhibit lower efficiency prior to their acquisition, and/or that less efficient firms should be more likely to be acquired. On the other hand, during our sample period, life insurers were undergoing significant technological changes. Advances in computer technology offer opportunities for aggressive insurers to gain a competitive advantage and market share, potentially both reducing average costs and enhancing revenues. One example of this changing environment has to do with customer interface. Whereas customer service personnel at the larger mutual fund companies have the capability to access information on a customer's entire portfolio almost instantaneously, few insurers are able to perform this function (Carr, 1997).[8] As with scale, one way to make technological gains relatively quickly is to acquire another firm with better technological capabilities. This suggests the hypothesis that firms with higher technical efficiency should be more attractive as merger partners or acquisition targets than firms that are not technically efficient, where technical efficiency is defined in terms of using the "best practice" technology.

Mergers and acquisitions in insurance also may be motivated by regulatory considerations. Insurers are regulated at the state level, with coordination provided by the National Association of Insurance Commissioners (NAIC). Following a sharp increase in insolvencies during the 1980s, the NAIC adopted a "solvency policing agenda" in 1989, including a risk-based capital (RBC) system adopted in 1993.[9] The objectives of the RBC system are to raise capital standards in the industry and to give regulators stronger authority to take action against financially troubled insurers.

Although many insurers restructured their asset portfolios and made other changes to improve their risk-based capital ratios,[10] the weaker insurers in the industry still face the prospect of having to raise additional equity capital to avoid incurring significant regulatory costs. Raising capital is problematical for many insurers because the industry contains many mutuals and closely held stock companies. Both of these organizational forms are more limited than widely held stock insurers in their ability to raise new capital. Moreover, information asymmetries with respect to the quality of the insurer's assets and the accuracy of its reserve estimates may raise the costs of external capital and thus make raising new capital unattractive to many insurers (Chamberlain and Tennyson, 1997). Insurers that face regulatory costs and capital constraints are likely to be attractive as acquisition targets for stronger firms, particularly if they are efficient and/or operating with favorable returns to scale. Information asymmetries between acquiring firms and targets are likely to be considerably less than those between the target insurers and the capital markets in general. Thus, we hypothesize that target firms are likely to display one or more signs of financial vulnerability.

We also hypothesize that companies that are members of insurance groups are more likely to be acquired than unaffiliated single companies. The rationale for this hypothesis is managerial entrenchment. The managers of an unaffiliated company face an uncertain future if their firm is acquired by another firm. This is especially true for top management — the group that has the most control over whether the acquisition takes place. Thus, managers of unaffiliated companies are likely to be resistant to takeover offers. Managers of insurance groups, on the other hand, are more likely to view the purchase and sale of individual companies as important components of their strategic arsenal and as potentially enhancing rather than threatening their personal economic value. Although group managers do have to confront the risk that a purchase or sale may turn out to be unprofitable, this risk to their job security is likely to be much less than the threat that a buy-out poses to managers of an unaffiliated firm.

Another rationale for mergers and acquisitions is earnings diversification.[11] Earnings diversification may provide a particularly strong motivation for mergers in the insurance industry. By increasing the breadth of the policyholder pool, losses become more predictable and earnings volatility due to the underwriting component of the insurer's operations is reduced. This potentially gives the insurer the opportunity to take on more risky and higher yielding investments, thus increasing revenues for a given level of overall risk and providing another rationale for the hypothesis that acquired firms should show greater revenue efficiency gains than non-M&A firms.

## 3. Life Insurance Industry Structure

This section provides a brief statistical overview of the structure of the life insurance industry during our sample period. This overview of industry structure is important to provide the backdrop for the merger analysis. We are not aware of any other current source that provides a rigorous analysis of the economic structure of the life insurance industry.

Consolidation in insurance has taken a different form from that occurring in banking. While consolidation in banking has resulted in the removal of thousands of banks from the market (Armel, 1996), the number of insurers has remained relatively constant. The reason for the difference is that branching and interstate banking restrictions prevented many banks from expanding outside their local areas. The insurance industry has not faced such restrictions; and, as a result, the insurance market has had greater opportunity to converge to an efficient equilibrium with regard to the number and geographical scope of firms. The result is a market dominated by firms that operate nationally or regionally.

The numbers of insurers with meaningful data reporting to the NAIC during the period 1988 through 1995 are shown in Table 1.[12] As mentioned above, most insurers are members of groups consisting of several companies under common ownership.[13] During our sample period the number of companies with a group affiliation remained relatively constant at about 900. The number of unaffiliated single companies declined by about 10 percent over the period, from 334 to 303. The relative constancy in the number of firms during an era when the industry is undergoing significant restructuring is due to the fact that many transactions involve groups buying and selling companies that remain in existence after the transaction. Another factor is that the numbers of firms exiting the market due to merger or insolvency have been partially offset by the formation of new insurers. Consequently, the restructuring of the life insurance industry primarily tends to involve such strategic objectives as an increased emphasis on core competencies or the expansion into new markets rather than the consolidation of geographically concentrated firms as in banking (Carr, 1997).

The distribution of premiums across the life insurance industry's five major lines of business is shown in Table 2. The table shows the importance of the annuity market for insurers – group annuities accounted for 24 percent of premium revenues in 1995 and individual annuities account for 22 percent. Another asset accumulation product, individual life insurance, accounts for another 25 percent of premium revenues. Group life and accident and health insurance, which are mainly indemnity rather than asset accumulation lines, account for the remaining 30 percent of revenues. Insurers make most of their profits from the margin between the investment yield earned on assets and the rate credited to policyholders. Thus, the asset accumulation products generate an even higher proportion of profits than their share of revenues (70 percent) would suggest. This is particularly noteworthy because it is in the asset accumulation markets that insurers face the most vigorous competition from banks, mutual fund companies, and investment advisory firms. Because these non-traditional competitors do not use agents and hence have much lower distribution costs than insurers, insurers face intense pressure to operate more efficiently in order to maintain their competitive viability in the increasingly important asset accumulation market.

Concentration trends in the industry are shown in Figure 1, which presents the Herfindahl indices by line of business over the sample period, based on premium volume. The indices are calculated by decision making unit, i.e., the market share proportions used to construct the indices are for groups and unaffiliated single companies. Consistent with the view that restructuring in the insurance industry primarily involves strategic realignment rather than changes in concentration, the Herfindahl indices are relatively constant over the sample period for the industry as a whole and for all lines except group life and group annuities. Concentration in group life insurance increased significantly over the sample period. Scale economies provide the most likely explanation for this trend. Group life is a highly competitive market with knowledgeable, cost conscious buyers (business firms), many of whom have the alternative of self insuring. Group life insurers thus compete in terms of the efficiency with which they can administer programs for the buyers, resulting in very low expense ratios and profit margins. Being able to spread the fixed costs of operating in the group life insurance business over a broader customer base thus is likely to be a major competitive advantage in this market. The explanation for the concentration trends in the group annuity market is somewhat different. Here concentration decreased significantly over the sample period because banks, mutual fund companies, and investment advisory firms (via their insurance affiliates or partners) have captured market share from the large life insurers that traditionally dominated this market.

Four, eight, and twenty-firm concentration ratios for the industry are presented in Table 3. The four-firm concentration ratios for assets, total premiums, individual annuity premiums, and group annuity premiums declined significantly over the sample period, reflecting a loss of market share by the mega-insurers such as Prudential and Metropolitan that traditionally dominated the industry. Although there are undoubtedly a number of factors that have driven this decline, it is consistent with the findings by Yuengert (1993) and Cummins and Zi (1998) that firms in this size class are characterized by decreasing returns to scale. In other words, scale inefficiency is likely to have contributed significantly to the market share loss of the mega-insurers. By way of contrast with individual and group annuities, the top four insurers gained significant market share in the group life insurance market. This is consistent with the argument that group life insurance is characterized by significant scale economies, whereas the relatively high costs of the large insurers relative to non-traditional competitors renders them vulnerable in the asset accumulation market.

## 4. Merger Activity in the Life Insurance Industry

This section of the paper summarizes merger and acquisition activity in the life insurance industry during our sample period 1989-1994. We first outline our methods of identifying merger and acquisition transactions and the criteria for their inclusion in our listing of transactions. We then summarize the number of target companies and the types of transactions we identified. Finally, we discuss our selection criteria for including a target in the analysis of the efficiency effects of mergers and acquisitions.

**Identification of Transactions**

Because there is no single authoritative source for information on mergers and acquisitions in the insurance industry, we conducted a search of a number of different sources to arrive at our estimate of the number of such transactions that occurred during our sample period. We first obtained a listing of large life insurance transactions from *Mergers and Acquisitions* magazine. This source reports all merger transactions valued at over $1 million prior to 1991 and those valued at over $5 million in subsequent years. We constructed additional data on acquisition activity from *Best's Insurance Reports*, by examining the composition of life insurance groups in each year.[14] We compiled a list of all changes in group composition, and the entry and exit of groups, reported by this source in each year from 1988 through 1995. We then investigated each of these group changes to distinguish those arising from mergers or acquisitions from other changes such as entry of new companies or retirements. To ascertain that these sources did not lead to under-representation of mergers and acquisitions of unaffiliated companies, we examined *Best's Review's* reports annual summaries of all mergers, entries, and exits in the insurance industry for each year of our sample period. Finally, we cross-checked our lists of transactions against the list of mergers and acquisitions compiled by Conning and Company, an investment banking and consulting firm specializing in the insurance industry. The final list of transactions used in our study represents the union of the transactions reported in the four sources, after screening to remove reported transactions that did not satisfy our sample selection criteria, discussed below.

To focus our study on transactions that involved a change in ownership of an insurance firm, we included in our database only complete acquisitions and acquisitions of a majority interest that were characterized by *Best's Insurance Reports* as resulting in a change in control. We excluded acquisitions of a minority interest and acquisitions of lines of business from our set of transactions. We also excluded all transactions which represented the internal restructuring of an existing insurance group. All potential transactions identified from the above list of sources were then further investigated in the company discussions contained in the relevant issues of *Best's Insurance Reports;* those transactions which could not be verified in this source were also excluded from our sample list.

We initially identified 317 firms that were targets of mergers and acquisitions during the period 1989-1994, an average of about 53 per year.[15] The largest number of events involved the purchase of a single company by another company or by a group, where the acquired company continued to operate as a distinct entity after the acquisition. On average, about 25 such targets were involved in acquisitions in each year during the sample period (1989-1994). The number of merger targets we identified, i.e., cases where a company was absorbed by another company, averaged about 7 per year. Another important category consists of cases where an entire group is acquired, usually by another insurance group. The number of companies involved in this type of transaction averaged 8.5 per year. A few companies were involved in more than one transaction during the sample period, for example by being purchased by one group and then later sold to another.

**Selection of Targets for Efficiency Analysis**

Our primary objective in this study is to test several hypotheses regarding the cost and revenue efficiency of firms that were targets of mergers and acquisitions. This necessitates imposing some further selection criteria to identify a sample of firms for which reported financial data are a meaningful representation of firm production activities and for which we can isolate the effects of acquisition in these data. To obtain this clean sample, we omit from the sample any target firm that was a shell company, in run-off or inactive prior to the acquisition.[16] In addition, we include only those target firms for which there is a two-year time horizon, both prior to and following their acquisition, in which they are free of other mergers and acquisitions activity. Activities that led to omission from the sample on this criterion included mergers or acquisitions of other companies (affiliated or unaffiliated), acquisitions of lines of business, a second acquisition of the target, or the acquisition of the target's parent company. Also excluded from the sample were firms that were retired or put into run-off or liquidation, at acquisition or within two years thereafter. Finally, in most of the analysis we analyze only those firms that continued to operate as active insurance concerns following the transaction, i.e., we primarily focus on acquisitions rather than mergers.

The sample selection criteria resulted in a sample size of 137 acquired firms for our primary analysis, of which efficiency scores could be estimated for 106.[17] We were unable to estimate efficiencies for some firms because they do not appear in our data base for one or more years of the sample period or because they exhibited unusual values for some key variables, such as negative premiums or negative net worth. These problems are symptomatic of firms that are experiencing financial difficulties or firms that were placed in runoff or liquidation but were not identified as such in our earlier screens. We believe that the result of our thorough analysis of the characteristics of the mergers and acquisitions in the insurance industry is that we have identified a well-defined sample consisting of nearly all acquired firms that continued to operate as viable decision making units following the acquisition.

## 5. Data and Methodology

This section briefly describes our data base and discusses the measurement of the outputs, inputs, and input prices used in estimating cost efficiency. The section concludes with a discussion of the data envelopment analysis (DEA) technique we use to measure efficiency and the Malmquist approach used to estimate changes in efficiency over time.

### The Data

The data used in our study are drawn from the regulatory annual statements filed by insurers with the National Association of Insurance Commissioners (NAIC). Because all insurers of any significant size are required to report to the NAIC, our data base initially consisted of virtually the entire industry. We eliminated firms with unusual characteristics such as zero or negative net worth, zero or negative premiums, and zero or negative input expenditures. We also eliminated firms with extreme or unusual financial ratios such as returns on equity greater or less than 100 percent, expense to asset ratios greater than 75 percent, etc. Such firms are clearly experiencing financial difficulties and tend to be non-viable operating entities. The final sample used to estimate efficiency by year consisted of approximately 750 firms per year, representing about 80 percent of industry assets. Because the Malmquist analysis requires that firms be present in each year of several overlapping blocks of five contiguous years, the sample size in the Malmquist estimation is smaller, consisting of about 550 companies per five year block. Output prices were also calculated using NAIC data, while data to calculate input prices were obtained from governmental sources (see below).

**Outputs and Inputs**

This section briefly discusses several measurement issues in constructing the data set. We first describe the process for choosing which services to measure as outputs in life insurance and explain how we measure outputs and output prices. We next turn to a discussion of the input quantities and the input prices used in our efficiency estimation.

**Outputs and Output Prices**. Insurers are analogous to other financial firms in that their outputs consist primarily of services, many of which are intangible. Three principal approaches have been used to define outputs in the financial services sector: the asset or intermediation approach, the user-cost approach, and the value-added approach (see Berger and Humphrey 1992b). Consistent with most of the recent literature, we adopt a modified version of the value-added approach, which counts as important outputs those that have significant value added, as judged using operating cost allocations.

Life insurers provide three principal services:

• **Intermediation.** The principal service provided by life insurers is financial intermediation. As discussed above, asset accumulation products (cash value life insurance and annuities) account for about 70 percent of revenues in the industry. Insurers' principal source of value added is reflected in the net interest margin between the rate of return earned on invested assets and the rate credited to policyholders. Insurers seek competitive investment returns by investing in assets that are not available to most investors, such as privately placed bonds, structured securities, and collateralized mortgage obligations.

• **Risk-pooling and risk-bearing.** Insurance provides a mechanism through which consumers and businesses exposed to losses can engage in risk reduction through pooling. In life insurance the principal risks are the risk of death (life insurance), the risk of longevity (annuities), and risk of loss from accidents or illness (accident and health insurance). The actuarial, underwriting, and related expenses incurred in risk pooling are important components of value added in the industry. Insurers also add value by holding equity capital to bear the residual risk of the pool.

• **"Real" financial services relating to insured losses.** Insurers provide a variety of real services for policyholders including personal financial planning and the administration of group life, annuity, and health insurance plans. By contracting with insurers to provide these services, policyholders can take advantage of insurers' extensive experience and specialized expertise to optimize their portfolios and reduce the costs associated with managing insurable risks.

In this study, we follow Yuengert (1993) in using incurred benefits plus additions to reserves to measure life insurance output.[18] Incurred benefits represent payments received by policyholders in the current year and thus are expected to be useful proxies for the risk-pooling and risk-bearing functions. Benefits are a measure of the amount of funds pooled by insurers and redistributed to policyholders as compensation for insured events.

Most life insurance and annuity products involve the accumulation of assets, either to pay future death benefits or to be received as income, either in a lump sum or through an annuity. The funds received by insurers that are not needed for benefit payments and expenses are added to policyholder reserves. Reserves in insurance are analogous to bank deposits and also to the bonds and other debt instruments issued by non-financial firms. The funds backing the reserves are invested by insurers in financial instruments. Additions to reserve thus are expected to be highly correlated with the intermediation function performed by life insurers. Both incurred benefits and additions to reserves are correlated with real services provided by insurers, such as benefit administration in the case of health insurance and financial planning in the case of individual life insurance and annuities.

Because the major lines of insurance offered by life insurers differ in the types of contingent events that are covered and in the relative importance of the risk-pooling/risk-bearing, intermediation, and real service components of output, we define five output variables, equal to the sum of incurred benefits and additions to reserve for the five major lines of business offered by life insurers – individual life insurance, individual annuities, group life insurance, group annuities, and accident and health insurance.[19] All outputs (assets, benefits, and policy face values) are expressed in real terms by deflating to 1982, using the Consumer Price Index (CPI).

In keeping with the value-added approach to output measurement, we define the price of each insurance output as the sum of premiums and investment income minus output for the line divided by output.[20] The approach is consistent with that used by Berger, et al. (1997) and other researchers. All quantities are expressed in real terms by deflating by the CPI prior to calculating the output prices.

**Inputs and Input Prices**. Insurance inputs can be classified into four groups — home office labor, agent labor, business services, and financial capital. We treat home office and agent labor separately because the two types of labor have different prices and are used in different proportions by firms in the industry.[21] We measure the price of home office labor using U.S. Department of Labor data on average weekly wages for Standard Industrial Classification (SIC) Class 6311, life insurance companies. The wages for the state in which the company maintains its home office are used in the analysis to proxy for the price of home office labor.[22]

The price of agent labor is measured using U.S. Department of Labor data on average weekly wages for SIC class 6411, insurance agents. A weighted average wage variable is used, with weights equal to the proportion of an insurer's premiums written in each state. We consider the weighted average approach more appropriate for agent labor than for home office labor because agency services are provided almost exclusively at the local level, whereas most of the other tasks performed by insurance company employees take place at the home office or in regional offices. The home office and agent wage variables are expressed in 1982 dollars by deflating by the CPI.

Labor is the most important non-interest expense for the insurance industry, accounting for about two-thirds of total non-loss expenses. Most of the remainder of insurer expenses are for various business services such as legal fees, travel, communications, advertising, and materials. Only a small fraction of expenses are for physical capital such as computers and buildings. Consequently, we do not define physical capital as a separate input but include it in the business services category. The price of business services is the average weekly wage in SIC sector 7300, business services. The wage series is deflated to 1982 dollars using the CPI.

Data on the number of employees or hours worked in the insurance industry are not available. Accordingly, we follow other insurance efficiency researchers (e.g, Berger, Cummins, and Weiss, 1997, Cummins and Zi, 1998) in measuring the quantity of agent and home office labor by dividing real dollar expenditures on these two expense categories by the agent and home office wage variables discussed above. The quantity of business services is defined similarly.

Our final input is the quantity of financial capital. Financial capital is an important input in insurance because insurers must maintain equity capital both to ensure policyholders that they will receive payment even if claims exceed expectations and to satisfy regulatory requirements. Capital costs represent a significant expense for insurers. The financial capital input is defined as the amount of equity capital reported by the insurer to the NAIC, deflated to 1982 dollars using the CPI.

The cost of capital in the insurance industry is difficult to measure because only a small minority of life insurers are publicly traded. We adopt a three-tier approach to measuring the cost of capital, based on financial ratings assigned by the A.M. Best Company, the leading financial rating firm for insurers. Best's uses a fifteen tier letter-coded rating system ranging from A++ for the strongest insurers to F for insurers currently in liquidation. The three tiers we adopt consist of the four ratings in the "A" range, the four ratings in the "B" range, and all other rating categories. Based on an examination of the equity cost of capital for traded life insurers, we assign a cost of capital of 12 percent to the top tier, 15 percent for the middle tier, and 18 percent for insurers in the lowest quality-tier. [23]

**Estimation Methodology**

We estimate efficiency using data envelopment analysis (DEA) (Charnes, et al., 1994). DEA is a non-parametric approach that does not require the specification of a cost function but rather computes an efficient "best practice" cost frontier based on convex combinations of firms in the industry. The alternative approach is to estimate an econometric cost frontier. Both DEA and the econometric approach have been used extensively in recent years, and both have strong advocates. The principal limitation of the econometric approach is that it requires the specification of a cost function and (in most variants) a distributional form for the error term, thus potentially confounding the efficiency estimates with specification error. The principal limitation of the DEA approach is that it does not permit insurers to deviate from the frontier due to random error but rather measures all departures from the frontier as inefficiency. However, a recent paper by Cummins and Zi (1998) provides evidence that econometric methods and DEA produce efficiency estimates for US life insurers that are quite consistent and highly correlated.[24] They also find that the DEA estimates of efficiency for life insurers are more highly correlated with conventional performance measures such as expense to premium ratios and return on assets than are the estimates obtained from the econometric approach. Based on these results, we consider DEA to be at least as appropriate as the econometric approach for measuring efficiency in the US life insurance industry.

second reason for choosing DEA as our estimation methodology is that the Malmquist approach, which is emerging as the dominant methodology for estimating the evolution of productivity and efficiency over time, is a DEA-based technique. Thus, the use of DEA permits us to use the same methodology consistently throughout the paper rather than using the non-parametric approach for some of our estimates and the econometric approach for others. A final important reason for using DEA is that it provides a particularly convenient method for decomposing cost efficiency into its components —

technical and allocative efficiency. Furthermore, the technique also provides a convenient way to measure economies of scale by decomposing technical efficiency into pure technical efficiency and scale efficiency. The decomposition is discussed in more detail below.

**Cost Efficiency.** To estimate "best practice" DEA cost frontiers for our sample firms, we use a two-step procedure. For DMU i, let $w_i = (w_{1i}, w_{2i}, \ldots, w_{Ki})^T$ denote the input price vector corresponding to the input vector $X_i = (x_{1i}, x_{2i}, \ldots, x_{Ki})^T$ and let $Y_i = (y_{1i}, y_{2i}, \ldots, y_{Ni})^T$ = the output vector, where T denotes the vector transpose, K is the number of inputs, and N is the number of outputs.

$$\underset{X_i}{Min} \sum_{k=1}^{K} w_{ki} \; x_{ki}$$

Then, we first solve the following problem:

Subject to

$x_{ki} \geq \Sigma_j \lambda_j x_{kj}$  k = 1,2,...,K,

$y_{ni} \leq \Sigma_j \lambda_j y_{nj}$ ,  n = 1,2,..,N,

$\lambda_j \geq 0$ ,  j = 1,2,.. I

where I = the number of firms. The solution vector $X_i^*$ is the cost minimizing input vector for the input price vector $w_i$ and the output vector $Y_i$. Second, calculate the ratio $\eta_i = w_i^T X_i^* / w_i^T X_i$ to get the cost efficiency measure for DMU i. The measure of cost efficiency for firm i, $\eta_i \leq 1$ , is interpreted as the proportion by which the firm could multiply its cost vector and still produce no less of any output. We conduct the estimation of the problem defined in (1) for each firm in the sample. The estimation is conducted year-by-year producing a best practice cost frontier for each year of the sample period.

Cost efficiency includes both technical efficiency and allocative efficiency. Allocative efficiency arises from firms using suboptimal combinations of inputs. Thus, firms can have higher costs than represented by the cost frontier because they are not using the most efficient technology (technical inefficiency) and/or because they use a suboptimal input mix (allocative inefficiency). To separate technical and allocative efficiency, we estimate technical efficiency using input distance functions, defined below. Having cost efficiency and technical efficiency enables us to back out estimates of allocative efficiency for the firms in the sample using the relationship: $CE(x_i,y_i) = TE(x_i,y_i)*AE(x_i,y_i)$, where $CE(x_i,y_i)$ = cost efficiency, $TE(x_i,y_i)$ = technical efficiency, and $AE(x_i,y_i)$ = allocative efficiency, all evaluated at input-output vector $(x_i,y_i)$.

**Technical Efficiency.** To measure technical efficiency we estimate "best practice" production frontiers, employing the input distance function introduced by Shephard (1970). Suppose producers use input vector $x = ( x_1, x_2,... x_k ) \in R_+^k$ to produce output vector $y = ( y_1, y_2, ..y_n ) \in R_+^n$. A production technology which transforms inputs into outputs can be modeled by an input correspondence $y \rightarrow V(y) \subseteq R_+^k$. For any $y \in R_+^n$, V(y) denotes the subset of *all* input vectors $x \in R_+^k$ which yield at least y (see, for example, Färe, Grosskopf, and Lovell, 1985, and Färe, 1988) . The input oriented distance function is defined by

$$D ( x , y ) = sup \{ \theta : ( \frac{x}{\theta} , y ) \in V( y ) \}$$

$$= ( inf\{ \theta : ( \theta x , y ) \in V( y ) \} )^{-1}$$

The input distance function is the reciprocal of the minimum equi-proportional contraction of the input vector x, given outputs y, i.e., Farrell's (1957) measure of input technical efficiency. Input technical efficiency TE(x,y) is therefore defined as

$$TE( x , y ) = \frac{1}{D( x , y )}$$

Like cost efficiency, technical efficiency is estimated separately for each firm in the sample by

$$(D(x_i, y_i))^{-1} = TE(x_i, y_i)$$

$$= \min \theta_i$$

$$\textit{subject to:}\ Y\lambda_i \geq Y_i$$

$$X\lambda_i \leq \theta_i X_i$$

solving linear programming problems. In this case, the linear programming problem is:

where **X** is a K x I input matrix and **Y** an N x I output matrix for all sample firms, $\mathbf{X}_i$ is a K x 1 input vector and $\mathbf{Y}_i$ an N x 1 output vector of firm i, $\lambda_i$ is an I x 1 intensity vector (the inequalities are interpreted as applying to each row of the relevant matrix), and i = 1, 2, . . ., I. This estimation produces a constant returns to scale (CRS) frontier. Again, the frontiers are estimated year by year.

With estimates of technical efficiency at hand, the next step is to decompose technical efficiency into its components, pure technical efficiency and scale efficiency, where $TE(x_i,y_i) = PT(x_i,y_i)*SE(x_i,y_i)$, $PT(x_i,y_i)$ = pure technical efficiency, and $SE(x_i,y_i)$ = scale efficiency. To provide some intuition into pure technical and scale efficiency, consider Figure 2, which portrays constant returns to scale and variable returns to scale production frontiers for a firm with one input (x) and one output (y). Technical efficiency (TE) is estimated relative to a constant returns to scale frontier, representing the long-run optimal scale of production. Consider a firm with input-output vector $(x_i, y_i)$. The firm operates below the constant returns to scale frontier shown in the figure as the line $0V^C$. Thus, it could produce its output while consuming less of the input by operating on the frontier. The measure of technical efficiency ($TE(x_i, y_i)$) for this firm is given by the ratio 0a/0c, i.e., the ratio of input consumption for a firm with output $y_i$ operating on the CRS frontier to the input consumption of firm i.

The decomposition of technical efficiency into pure technical and scale efficiency can be illustrated by considering the variable returns to scale frontier labeled $V^V$ in Figure 2. Pure technical efficiency ($PT(x_i,y_i)$) is measured relative to this VRS frontier and in this case $PT(x_i, y_i)$ = 0b/0c, the proportion of its inputs firm would use if it adopted the "best practice" technology. Scale efficiency ($SE(x_i, y_i)$) is then measured in relation to the distance between the VRS frontier and the CRS frontier, i.e., $SE(x_i, y_i)$ = 0a/0b. This represents an additional proportion by which input usage could be reduced by attaining constant returns to scale. Thus, $TE(x_i,y_i) = PT(x_i,y_i)*SE(x_i,y_i)$ = (0b/0c)*(0a/0b) = 0a/0c.

Pure technical and scale efficiency are separated by solving problem (4) with the additional constraint:

$$\sum_{i=1}^{I} \lambda_i = 1$$

for a variable returns to scale (VRS) frontier, and again with the constraint

$$\sum_{i=1}^{I} \lambda_i \leq 1$$

for a non-increasing returns to scale (NIRS) frontier. Pure technical efficiency (PT) is obtained by solving the VRS problem, and scale efficiency is then obtained as $SE(x_i,y_i) = TE(x_i,y_i)/PT(x_i,y_i)$. If $SE(x_i,y_i) = 1$, CRS is indicated. If $S \neq 1$ and the NIRS efficiency measure = PT, DRS is present; whereas if $S \neq 1$ and the NIRS efficiency measure $\neq$ PT, then IRS is indicated.

**Malmquist Analysis.** If technology is improving over time, we will observe shifts in the frontier. Malmquist analysis permits us to separate shifts in the frontier (*technical change)* from improvements in efficiency relative to the frontier (*technical efficiency change*). The product of technical change and technical efficiency change, *total factor productivity change*, is measured by the Malmquist index (for further details, see Grosskopf, 1993). To illustrate the Malmquist approach, consider the single input, single output case represented in Figure 3. The line labeled $0V^t$ in the figure represents the production frontier in period t, whereas $0V^{t+1}$ represents the frontier in period t+1. The improved technology represented by $0V^{t+1}$ enables efficient firms to produce the output using less of the input than was required by technology $0V^{t}$.

Suppose that our hypothetical firm has input-output combination $(x_i^t, y_i^t)$ in period t and $(x_i^{t+1}, y_i^{t+1})$ in period t+1. Two principal changes have occurred between period t and period t+1. First, because of technical progress, the firm produces more output per unit of input in period t+1 than in period t. In fact, its input-output combination in period t+1 would have been infeasible using period t technology. Thus, technical change has taken place. Second, the firm has also experience technical efficiency change because its operating point is closer (in relative terms) to the frontier in t+1 than it was in period t. The Malmquist approach can be used to measure both shifts in the frontier over time and changes in efficiency relative to the frontiers for different time periods.

Malmquist analysis involves the use of distance functions. To define the Malmquist index for the production frontier, we modify equation (2) to incorporate time and define input distance functions with respect to two different time periods as:[25]

$$D^{t+1}(x^t, y^t) = \sup\{\theta : (\frac{x^t}{\theta}, y^t) \in V^{t+1}(y^t)\}$$

$$D^{t}(x^{t+1}, y^{t+1}) = \sup\{\theta : (\frac{x^{t+1}}{\theta}, y^{t+1}) \in V^{t}(y^{t+1})\}$$

where $D^t$ ($D^{t+1}$) represents the distance function relative to the frontier at time t (t+1), and $x^t$ and $y^t$ ($x^{t+1}$ and $y^{t+1}$) are the input and output vectors at time t (t+1). In equation (5), the input-output bundle in time period t is evaluated relative to the technology of time period t+1; while in equation (6) the input-output bundle observed in period t+1 is evaluated relative to the technology of time t. In Figure 3, $D^{t+1}(x_i^t, y_i^t)$ = 0a/0c and $D^t(x_i^{t+1}, y_i^{t+1})$ = 0e/0d. Notice that cross-frontier distance function estimates can be less than 1, whereas distance function estimates for a given year's input-output bundle relative to the frontier for the same year must be ≥ 1. A distance function value less than one for $D^t(x_i^{t+1}, y_i^{t+1})$ implies that the specified input-output combination is infeasible using the technology of period t.

Malmquist indices can be defined relative to either the technology in period t or the technology in period t+1, as follows:

$$M^t = \frac{D^t(x^t, y^t)}{D^t(x^{t+1}, y^{t+1})} \quad or \quad M^{t+1} = \frac{D^{t+1}(x^t, y^t)}{D^{t+1}(x^{t+1}, y^{t+1})}$$

where $M^t$ measures productivity growth between periods t and t+1 using the technology in period t as the reference technology, while $M^{t+1}$ measures productivity growth with respect to the technology in period t+1. To avoid an arbitrary choice of reference technology, the input-oriented Malmquist index of total factor productivity is defined as the geometric mean of $M^t$ and $M^{t+1}$ (Grosskopf, 1993):[26]

$$M(x^{t+1}, y^{t+1}, x^t, y^t) = [(\frac{D^t(x^t, y^t)}{D^t(x^{t+1}, y^{t+1})})(\frac{D^{t+1}(x^t, y^t)}{D^{t+1}(x^{t+1}, y^{t+1})})]^{\frac{1}{2}}$$

**(8)**

In Figure 3, the total factor productivity index is equal to [{(0a/0b)/(0e/0d)][(0a/0c)/(0e/0f)}]$^{½}$ .

The Malmquist productivity index can be decomposed into measures of technical efficiency change and technical change, by factoring as follows:

$$M(x^{t+1}, y^{t+1}, x^t, y^t) = (\frac{D^t(x^t, y^t)}{D^{t+1}(x^{t+1}, y^{t+1})})\ [(\frac{D^{t+1}(x^{t+1}, y^{t+1})}{D^t(x^{t+1}, y^{t+1})})(\frac{D^{t+1}(x^t, y^t)}{D^t(x^t, y^t)})]^{\frac{1}{2}}$$

**(9)**

The first ratio in equation (9), in parentheses, represents technical efficiency change, i.e., the relative distance of the input-output bundle from the frontier in periods t and t+1. Recall that both the numerator and denominator of the ratio must be ≥ 1 and that values closer to 1 represent higher efficiency. Thus, if technical efficiency is higher in period t+1 than in period t, the value of this ratio will be > 1; while if efficiency declines between the two periods, the value of the ratio will be < 1. In terms of Figure 3, technical efficiency change is measured as the ratio [(0a/0b)/(0e/0f)]. The second factor in equation (9) is a geometric mean representing technical change (shifts in the frontier) between periods t and t+1. Values of the second factor > 1 imply technical progress and values < 1 imply technical regress. The distance functions (equations (5) and (6)) are measured by solving mathematical programming problems similar to expression (4).

In our analysis, we are interested in the change in efficiency for firms that are acquisition targets between the period prior to the acquisition and the period after the acquisition. The year immediately prior to the acquisition year and the year immediately afterwards are likely to be unrepresentative of the past and future efficiency of the acquisition target. In the year before the transaction year, transactions are likely to take place in preparation for the acquisition that are non-representative of normal operations and in the year after acquisition the firm is likely to be intensively involved in post-merger integration with the parent concern and its new affiliates. Consequently, to filter out to the extent possible, given our data base, the abnormal activities associated with the acquisition, we use Malmquist analysis to measure technical efficiency change and technical change between the year two years prior to acquisition (t-2) to the year two years after acquisition (t+2). The analysis thus involves a sequence of overlapping five-year blocks of data centered on the acquisition years 1990 through 1993. This represents the maximum number of such blocks available in our data base.

**Revenue Efficiency.** Revenue efficiency is estimated similarly to cost efficiency. However, in this case we adopt an output oriented rather than an input oriented approach and maximize revenues rather than minimizing costs. The setup of the problem is suggested by Lovell (1993). Specifically, the following problem is solved for each firm in each year of the sample period:

$$\underset{Y_i}{Max} \sum_{n=1}^{N} p_{ni} \; y_{ni}$$

$$\text{Subject to} \quad x_{ki} \geq \Sigma_j \lambda_j x_{kj} \qquad k = 1,2,...,K,$$

$$y_{ni} \leq \Sigma_j \lambda_j y_{nj}\,, \qquad n = 1,2,..,N,$$

$$\lambda_j \geq 0\,, \qquad j = 1,2,..\,I$$

where I = the number of firms. The solution vector $Y_i$* is the revenue maximizing output vector for the output price vector $p_i$ and the input vector $X_i$. Revenue efficiency is then measured by the ratio $\kappa_i = p_i^T Y_i / p_i^T Y_i^* \leq 1$. Linear programming is used to solve the problem defined in (10).

## 6. Estimation Results

This section presents the results of our analysis of the relationship between mergers and acquisitions and efficiency in the US life insurance industry. We focus primarily on firms that were acquired during the period 1990-1993 that continued to operate for at least two years following the acquisition. Focusing on target firms that continue to operate provides a relatively homogeneous sample consisting of the most common type of merger/acquisition transaction among life insurers.

We first present summary statistics on the characteristics of the firms in the sample and the results of the DEA and Malmquist analyses. We next conduct a regression analysis where the dependent variables represent changes in various types of efficiency over a period ranging from two years prior to the year of acquistion to two years after the year of acquisition. This analysis is designed to test for changes in efficiency while controlling for characteristics of target and non-M&A firms that are hypothesized to be related to efficiency changes. The objective of the regression analysis is to investigate the principal issue addressed in this paper, i.e., whether acquisitions lead to improvements in efficiency.

Finally, we conduct a probit analysis where the dependent variable is set equal to 1 for target firms and to 0 for firms with no merger/acquisition activity. This analysis is intended to identify the predictor variables characterizing target firms, and thereby to test several of the hypotheses discussed above.

**Summary Statistics**

We begin the discussion by presenting some summary statistics on the target and non-M&A firms in our sample (see Table 4). The table shows several statistically significant differences between the target and non-M&A firms. Consistent with our hypothesis that firms characterized by non-decreasing returns to scale are more attractive as acquisition targets, the proportion of target firms operating with non-decreasing returns to scale is significantly higher than for non-M&A firms. And consistent with our hypothesis that acquisition targets may display signs of financial vulnerability, target firms have significantly lower ratios of operating cash flow to assets and are significantly less likely to be rated A+ by the A.M. Best Company. As expected, target firms are also less likely to be mutuals.[27] Target companies also are significantly less likely to be unaffiliated single firms than are the non-M&A targets. This is consistent with the argument that managerial entrenchment provides a barrier to the acquisition of unaffiliated companies. Finally, target companies are somewhat smaller in terms of assets than non-M&A firms and are significantly less concentrated geographically, consistent with the view that acquiring firms prefer targets that are relatively more diversified geographically.

The average efficiencies for US life insurers over the period 1989-1994 are presented in Table 5. The table compares the firms that were targets of acquisitions to all non-M&A firms for which efficiency estimates are available. We conduct t-tests for differences between means for the target and all non-M&A samples. Considering the comparisons based on the entire sample period, target firms have significantly higher technical, pure technical, and scale efficiency than the non-M&A firms. In addition, the comparison of Malmquist indices shows that target firms experienced significantly larger gains in technical efficiency and in total factor productivity over the sample period than did the non-M&A firms.

These findings are consistent with the view that more technically efficient and scale efficient firms tend to be more attractive as acquisition targets than firms that are less technically and scale efficient. The results also suggest that acquisitions lead to efficiency gains for target firms.[28]

**Regression Analysis of Efficiency Changes**

To analyze efficiency changes while controlling for other important differences between target firms and the non-M&A firms, we estimate regressions with efficiency changes as dependent variables and firm characteristics as independent variables. The Malmquist analysis provides estimates of technical efficiency change, technical change, and total factor productivity change; and these three indices are used separately as dependent variables. We also conduct regressions where the dependent variable is the ratio KE(t+2)/KE(t-2), where KE stands for efficiency of type K and K = C, A, T, PT, and S, representing, respectively, cost, allocative, technical, pure technical, and scale efficiency.[29]

The independent variables include size (log of assets), organizational form (a dummy variable = 1 if the firm is a mutual and zero otherwise), ownership type (a dummy variable = 1 if the firm is an unaffiliated single company and equal to zero otherwise), and business mix (the proportions of the firm's premiums in group life, group annuities, individual annuities, and accident and health insurance, with individual life insurance being the excluded category). To control for geographical concentration, we include the firm's geographical Herfindahl index, which is based on the proportions of business written by state. A firm with a high geographical Herfindahl index has a substantial share of its business concentrated in one or a few states, while firms with lower Herfindahl indices tend to have their business more evenly distributed across a larger number of states. To determine whether acquisitions improve firm efficiency, we include a dummy variable equal to 1 if the firm was acquired during the period and zero otherwise.

As explained above, the sample period for the regressions is 1990 through 1993 to permit us to measure the change in efficiency over a period beginning two years prior to the acquisition year (t-2) and ending two years after the acquisition year (t+2). Thus, efficiency changes are measured across overlapping five year periods centered on acquisition years. In order to be included in a five-year block, firms are required to be present in all years represented by the block. However, we do not require firms to be present in all years of the sample period (1988-1995) in order to be included in the analysis. Thus, the firms included in the five-year blocks (1988-1992, 1989-1993, 1990-1994, and 1991-1995) differ somewhat over time. The target firms in our sample are included in the data set only for the five-year block surrounding their acquisition; other merged or acquired firms that were omitted from our sample based on our selection criteria are eliminated from the database for this analysis. The same sample of firms is used for both the Malmquist regressions and the regressions where the ratios KE(t+2)/KE(t-2) are used as the dependent variables.

The regressions, presented in Table 6, reveal that the Malmquist indices of technical change and total factor productivity change are significantly larger for target firms than for non M&A firms. Because the Malmquist index of technical change does not differ significantly between the two groups of firms, the difference in total factor productivity change is due almost exclusively to technical efficiency change. The target company dummy variable in the regression with the ratio TE(t+2)/TE(t-2) as the dependent variable is also statistically significant, primarily due to pure technical efficiency gains rather than changes in scale efficiency. The regression results thus provide strong evidence that target firms registered significantly larger gains in technical efficiency than firms that were not involved in M&A activity over the sample period, confirming the results presented in Table 5.

The other regressions shown in Table 6 reveal that target firms also experienced significantly larger gains in both cost and revenue efficiency than did non-M&A firms. The cost efficiency gains appear to be attributable primarily to gains in technical rather than allocative efficiency. This provides further evidence that acquisitions have had a beneficial effect on efficiency in the life insurance industry, and that the gains affect revenues as well as costs.

The control variables in the regressions reveal that larger firms experienced significantly smaller efficiency changes than smaller firms. Mutual firms achieved significantly lower efficiency growth than stock firms, except for scale and revenue efficiency where there is no significant difference between stocks and mutuals. The technical and cost efficiency differences between stocks and mutuals could be consistent with "expense preference" behavior on the part of mutuals (e.g., Mester, 1989), and/or it could provide further evidence that mutuals operate in less complex and less risky lines of business that may provide fewer opportunities for technological gains.[30] Geographically concentrated firms experienced smaller changes in technical, cost, and revenue efficiency than firms operating over broader geographical areas, but such firms also experienced significantly greater technical change than more geographically diversified firms. (However, the net effect, as reflected in the equation with total factor productivity change as the dependent variable, is a significant negative relationship between total factor productivity change and the geographical Herfindahl index). A possible explanation for this finding is that technological advances in data transmission and communications may provide more opportunities for improving efficiency for firms that are relatively diversified geographically.

Firms with higher proportions of their premium revenues in the group life insurance line of business experienced significantly lower growth in all types of efficiency except scale efficiency but experienced significantly more technical change than firms that are less active in group life insurance. This is consistent with the view that group life insurance is a highly competitive and efficient line of business, because the opportunity for efficiency gains would be lower in a relatively efficient line. However, because the line is already highly efficient and competitive, firms have a strong incentive to adopt new technology in order to remain viable as market participants and/or to gain competitive advantages over their rivals. Efficiency gains were also significantly lower in the accident and health line of business, perhaps because this line is already relatively efficient due to the intensive pressure to control costs in the health care industry.

**Probit Analysis of the Probability of Acquisition**

The probit analysis of the probability that a firm becomes an acquisition target is presented in Table 7. The dependent variable in this analysis is equal to 1 for firms that were acquired and equal to zero for non-M&A firms. The independent variables in the regression are lagged one year so that firm characteristics prior to the acquisition year are associated with what occurs during the acquisition year. Acquired firms are included in the probit analysis only in the year of their acquisition. Targets of merger activity or acquisition targets that were omitted from our sample based on other selection criteria are eliminated from the data set entirely.[31] Non-M&A firms are included for all sample years (1989-1994).

The probit models include several explanatory variables to test the hypotheses discussed in section 2 as well as some control variables. To test the hypothesis that firms exhibiting increasing or constant returns to scale are more attractive acquisition targets than firms exhibiting decreasing returns to scale, we include a dummy variable set equal to 1 if the firm exhibits non-decreasing (increasing or constant) returns to scale and to zero otherwise. A positive coefficient on this variable would support the hypothesis. To test the hypothesis that efficient firms, and particularly those that are technically efficient, are more attractive targets, we include efficiency ratios in the regressions. Because these ratios tend to be highly correlated, we include only one type of efficiency ratio in each equation. Positive coefficients on one or more of the efficiency variables would support our hypothesis.

Several variables are included in the equations to test the hypothesis that financially vulnerable firms are likely to be acquisition targets. The ratio of equity capital to assets is used to measure the adequacy of the firm's capitalization. We also include the ratio of net operating cash flow to assets as a measure of the adequacy of funds to invest in new projects, and the one-year growth rate in premiums to measure growth opportunities. As a liquidity ratio, we use the ratio of cash and invested assets to liabilities, a commonly used liquidity measure for insurers. We expect all of these variables to be inversely related to the probability that a firm is acquired.

We include a dummy variable equal to 1 for unaffiliated single firms and zero otherwise to test the managerial entrenchment hypothesis, i.e., the hypothesis that managers of unaffiliated single firms are likely to resist buy-out offers to protect their job security. A negative coefficient on this variable would be consistent with the managerial entrenchment hypothesis.

As control variables, we include the log of assets to capture size effects; and a dummy variable equal to 1 if the firm is a mutual and equal to zero otherwise. Conventional wisdom would predict a negative coefficient for the log of assets, and the mutual dummy is also expected to have a negative sign because mutuals are more difficult to acquire than stocks. The geographical Herfindahl index is included to control for the degree of geographical diversification. We do not have a strong prediction regarding the sign of this variable. If firms are seeking to expand into new markets, it might make sense to acquire firms that specialize in particular states and regions because of their knowledge of the market. On the other hand, firms seeking earnings diversification may find it cost effective to acquire one or two firms whose operations cover broader geographical areas rather than acquiring several single state firms, both in terms of the legal and administrative fixed costs of an acquisition and the costs of post-acquisition integration. Our final control variables consist of business mix percentages and year dummies.

The probit results (see Table 7) provide strong support for the hypothesis that firms exhibiting non-decreasing returns to scale are more likely to be acquisition targets. The non-decreasing returns to scale dummy variable is positive and significant in every equation. We also find some support for the hypothesis that more efficient firms are attractive merger targets. All efficiency variables with the exception of allocative efficiency are positively related to the probability of acquisition, although only revenue efficiency is statistically significant. This suggest that firms with relatively high revenue efficiency are especially attractive as acquisition targets.

The results also support the hypothesis that financially vulnerable firms are more likely than strong firms to become acquisition targets. The capital-to-asset ratio is statistically significant at the 5 percent level in all of the probit regressions, with the expected negative sign in all cases. The ratio of net operating cash flow to liabilities is significant at the 5 percent level or better in all models, also with the expected negative sign. The premium growth variable also has the expected negative sign but is not statistically significant. The only financial strength variable that has an unexpected sign is the ratio of liquid assets to reserves, which is positively related to the probability of acquisition, although not statistically significant. A possible explanation for this result is that the liquidity ratio may proxy both for financial vulnerability (suggesting a negative coefficient) and for the attractiveness of the firms as an acquisition target (suggesting a positive coefficient). That is, after controlling for capitalization, cash flow, and other factors, the acquiring firm is better off with liquid assets (cash and tradeable securities) than with non-earning assets such as receivables from agents and reinsurers, and this effect offsets the role of this variable as an indicator of financial vulnerability.

The unaffiliated single firm dummy variable has a negative coefficient as expected and is statistically significant at the 1 percent level or better in all of the probit models. This provides strong support for the hypothesis that managers of unaffiliated single firms have an incentive to resist takeovers. As expected, the equations provide evidence that mutuals are less likely to be acquired than stocks. Geographically diversified firms are more likely to be acquired than firms operating more narrowly, consistent with the earnings diversification/costs of acquisition hypothesis. The log of assets is inversely related to acquisition probability, supporting the conventional view that acquisition targets tend to be relatively small. None of the business mix variables is statistically significant.

## 7. Conclusions

This paper examines the relationship between acquisitions, efficiency, and scale economies in the US life insurance industry. We estimate efficiency for life insurers representing 80 percent of industry assets over the period 1988-1995. Our estimation technique is data envelopment analysis (DEA), which has been shown to perform well as an efficiency measurement technique for the life insurance industry

(Cummins and Zi, 1998). DEA is also attractive in this context because it provides a particularly convenient approach for decomposing cost efficiency into technical and allocative efficiency and for decomposing technical efficiency into pure technical and scale efficiency. To measure technical efficiency change, technical change, and total factor productivity change over time, we also make use of the Malmquist index methodology.

We investigate five principal hypotheses: (1) that acquisitions lead to improvements in efficiency for the acquired firm; (2) that firms operating with non-decreasing returns to scale are more attractive acquisition targets than firms operating with decreasing returns to scale; (3) that efficient firms are more likely to be acquired than inefficient ones; (4) that financially vulnerable firms are more likely to be acquired; and (5) that unaffiliated single insurers are less likely to be acquired than insurers that are members of groups because entrenched managers of unaffiliated insurers fear the loss of job security. The hypotheses are founded on economic and financial theory. The fourth is also motivated by regulatory considerations, particularly the adoption of risk-based capital, which exposes weaker firms to potentially significant regulatory costs.

To test the hypothesis that acquisitions lead to improvements in efficiency, we regress the change in efficiency two-years after acquisition vs. two-years prior to acquisition on a dummy variable set equal to 1 for acquisition targets and to zero for non-M&A firms as well as a set of control variables. The results provide strong evidence that acquired firms achieve greater gains in technical, cost, and revenue efficiency than non-M&A firms, suggesting that the recent restructuring of the life insurance industry has produced significant efficiency gains. We do not find significant differences in allocative or scale efficiency between acquisition targets and non-M&A firms.

Probit models are used to investigate hypotheses (2) through (5). We provide support for the hypothesis that firms characterized by non-decreasing returns to scale are significantly more likely to become acquisition targets than firms operating with decreasing returns to scale. This suggests that insurers have generally acted rationally by avoiding acquisitions of firms that are already too large. We also provide evidence that financially vulnerable insurers are more likely to be acquired than financially stronger firms. Thus, regulation also appears to have driven consolidation among life insurers. Although firm efficiency is generally positively related to the probability of acquisition, this relationship is statistically significant only for revenue efficiency. This suggests that acquiring firms consider a potential target's potential in the product market to be more important than its cost or technical efficiency, perhaps on the grounds that it is easier to make internal improvements after the acquisition than to replicate a competitive advantage in generating revenue.

The overall conclusion is that mergers and acquisitions in the life insurance industry appear to be driven for the most part by economically viable objectives and have had a beneficial effect on efficiency in the industry. We expect to see more consolidation in the industry in the future. There are still many insurers that are burdened with excessively costly agency distribution systems that in the long-run will not be able to compete with banks, mutual funds, and investment advisory firms. The pressures on inefficient insurers will become even more intense if Glass-Steagall is repealed. Glass-Steagall repeal also can be expected to motivate more mergers and acquisitions, as banks seek to enter the market with their own insurance subsidiaries. The competitive landscape would change even more profoundly if the Federal income tax code were revised to reduce or eliminate the tax deferral on interest earnings accumulated in life insurance and annuity contracts. Moreover, although some firms have made progress technologically, there are still many firms in the industry that have not been able to effectively exploit technology to create value for shareholders and policyholders. Additional research will be needed to determine whether future restructuring is economically beneficial.

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# Figure 1: Herfindahl Indices By Line For the US Life Insurance Industry

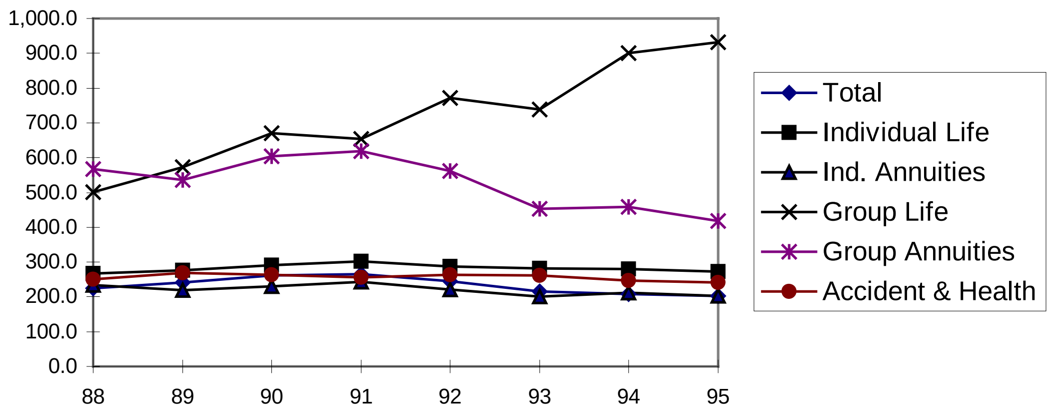

Figure 2: Pure Technical and Scale Efficiency

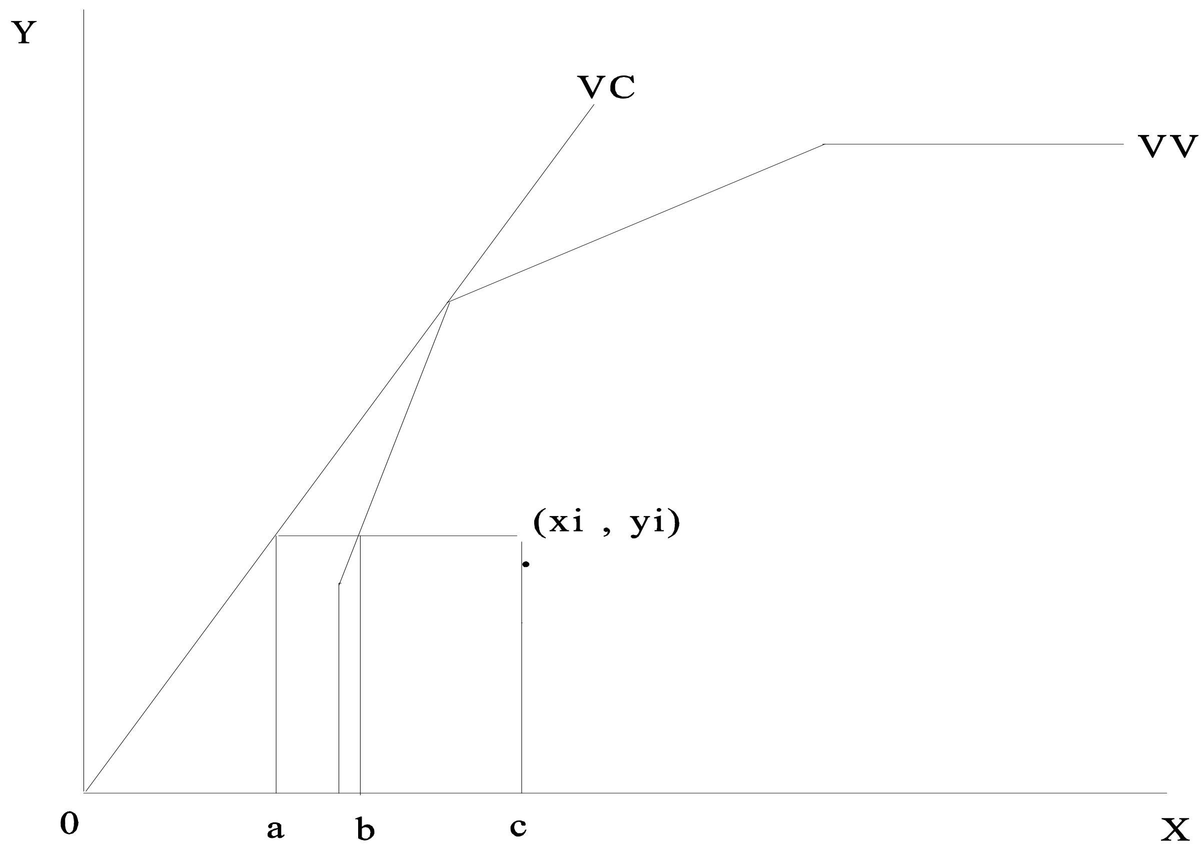

Figure 3: Productivity and Efficiency Change

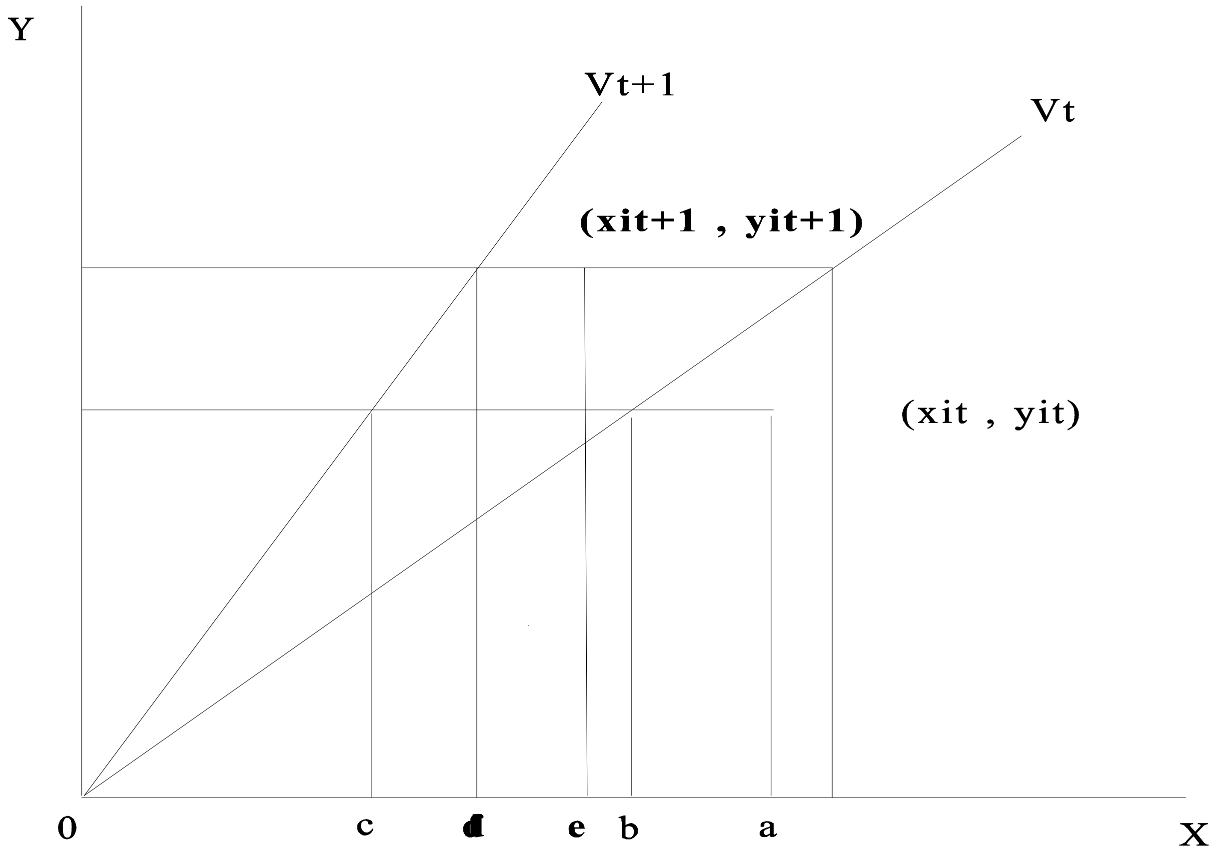

**Table 1**
**US Life Insurance Industry: Number of Firms**

| Year | No. of Groups | Affiliated Companies | Unaffiliated Companies | Companies | DMUs |
|---|---|---|---|---|---|
| **1988** | 379 | 891 | 334 | 1,225 | 713 |
| **1989** | 379 | 907 | 337 | 1,244 | 716 |
| **1990** | 379 | 916 | 341 | 1,257 | 720 |
| **1991** | 381 | 941 | 363 | 1,304 | 744 |
| **1992** | 381 | 936 | 352 | 1,288 | 733 |
| **1993** | 369 | 902 | 339 | 1,241 | 708 |
| **1994** | 357 | 899 | 334 | 1,233 | 691 |
| **1995** | 341 | 884 | 303 | 1,187 | 644 |

**Table 2**
**Distribution of Premiums by Line of Business**

| Year | Individual Life | Individual Annuities | Group Life | Group Annuities | Accident &Health | Total* |
|---|---|---|---|---|---|---|
| **1988** | 27.0% | 17.2% | 6.9% | 25.2% | 23.6% | $224,733 |
| **1989** | 25.0% | 18.6% | 6.6% | 26.3% | 23.5% | $244,196 |
| **1990** | 23.8% | 19.2% | 6.6% | 27.9% | 22.6% | $266,381 |
| **1991** | 24.2% | 19.0% | 6.3% | 26.3% | 24.2% | $270,026 |
| **1992** | 24.6% | 20.8% | 6.7% | 24.7% | 23.3% | $285,034 |
| **1993** | 25.0% | 22.1% | 6.5% | 23.5% | 22.9% | $315,872 |
| **1994** | 24.7% | 23.5% | 7.0% | 21.9% | 23.0% | $336,665 |
| **1995** | 24.6% | 21.6% | 7.0% | 23.6% | 23.2% | $350,238 |

*Premiums are in millions of current dollars.

**TABLE 3 - Concentration Ratios For the US Life Insurance Industry**

| | Assets | | | Total Premiums | | | Individual Life Premiums | | | Individual Annuity Premiums | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **N=** | 4 | 8 | 20 | 4 | 8 | 20 | 4 | 8 | 20 | 4 | 8 | 20 |
| **Year** | | | | | | | | | | | | |
| **88** | 27.4% | 39.4% | 56.5% | 21.0% | 29.8% | 45.0% | 23.3% | 31.5% | 47.9% | 19.0% | 29.8% | 51.1% |
| **89** | 26.2% | 37.9% | 55.2% | 22.2% | 31.1% | 46.6% | 24.3% | 34.6% | 51.6% | 17.7% | 28.8% | 49.4% |
| **90** | 24.7% | 36.4% | 53.9% | 23.8% | 32.6% | 49.4% | 26.3% | 35.4% | 52.1% | 19.7% | 32.7% | 51.1% |
| **91** | 24.4% | 35.7% | 53.9% | 23.1% | 33.0% | 50.1% | 26.6% | 35.8% | 51.8% | 20.3% | 33.9% | 51.9% |
| **92** | 23.6% | 34.4% | 52.9% | 22.4% | 31.7% | 48.7% | 27.1% | 37.0% | 53.9% | 19.8% | 31.8% | 49.4% |
| **93** | 22.8% | 33.3% | 51.9% | 20.6% | 29.7% | 47.5% | 26.2% | 37.3% | 54.8% | 17.7% | 28.8% | 51.0% |
| **94** | 21.9% | 31.8% | 50.9% | 19.9% | 29.1% | 46.1% | 25.3% | 35.7% | 52.0% | 16.2% | 27.9% | 47.9% |
| **95** | 21.4% | 31.4% | 51.1% | 19.6% | 29.0% | 45.7% | 24.8% | 35.5% | 52.7% | 16.2% | 28.2% | 49.1% |

| | Group Life Premiums | | | Group Annuity Premiums | | | Accident & Health Premiums | | |
|---|---|---|---|---|---|---|---|---|---|
| **N=** | 4 | 8 | 20 | 4 | 8 | 20 | 4 | 8 | 20 |
| **Year** | | | | | | | | | |
| **88** | 36.6% | 47.7% | 61.7% | 37.0% | 54.8% | 77.4% | 20.0% | 31.8% | 52.3% |
| **89** | 37.8% | 49.6% | 63.1% | 37.2% | 53.8% | 77.0% | 21.4% | 33.1% | 52.1% |
| **90** | 41.4% | 52.4% | 65.7% | 40.1% | 57.1% | 78.4% | 20.6% | 34.0% | 52.9% |
| **91** | 42.7% | 54.2% | 67.2% | 39.4% | 58.1% | 81.1% | 21.0% | 33.5% | 54.0% |
| **92** | 45.5% | 55.8% | 68.7% | 37.9% | 56.5% | 78.3% | 22.1% | 34.5% | 53.6% |
| **93** | 43.0% | 52.7% | 68.2% | 33.8% | 52.9% | 75.9% | 22.4% | 33.9% | 53.7% |
| **94** | 45.4% | 54.0% | 69.4% | 33.2% | 52.6% | 75.5% | 22.1% | 33.1% | 53.0% |
| **95** | 46.8% | 56.1% | 70.6% | 29.8% | 48.5% | 73.2% | 22.3% | 32.9% | 51.4% |

**Table 4**
**Summary Statistics on Target and Non-M&A Firms**
**1989-1994 Averages**

| | **Target Firms** | | | **Non M&A Firms** | |
|---|---|---|---|---|---|
| **Variable** | **Mean** | **Std. Dev.** | | **Mean** | **Std. Dev.** |
| Total assets (millions) | $1,876.14 | $203.21 | * | $1,904.65 | $206.84 |
| Capital/Total assets | 0.203 | 0.182 | | 0.213 | 0.170 |
| Liquidity ratio | 1.606 | 2.380 | | 1.348 | 1.451 |
| Operating cash flow/Total assets | 0.029 | 0.210 | *** | 0.087 | 0.137 |
| Invested assets/Total assets | 0.940 | 0.060 | | 0.940 | 0.068 |
| Percent of invested assets in real estate | 1.7% | 3.0% | | 1.7% | 3.2% |
| Percent of invested assets in stocks | 4.3% | 6.2% | *** | 6.4% | 9.4% |
| Percent of invested assets in bonds | 72.3% | 20.1% | * | 68.9% | 20.1% |
| Percent of invested assets in mortgages | 6.7% | 9.6% | ** | 8.7% | 11.7% |
| Total premiums (millions) | $238.55 | $762.52 | * | $361.74 | $1,468.28 |
| Percent change in premiums, t-1 to t | 104.9% | 89.6% | * | 117.3% | 93.3% |
| Percent of premiums in group life | 9.9% | 18.6% | | 11.0% | 20.7% |
| Percent of premiums in group annuities | 4.5% | 15.6% | | 4.8% | 13.8% |
| Percent of premiums in accident/health | 26.5% | 32.6% | | 29.0% | 35.6% |
| Percent of premiums in indiv. annuities | 20.2% | 31.0% | | 17.4% | 26.9% |
| Percent of cos with non-decr. rets to scale | 73.3% | 44.5% | *** | 60.3% | 48.9% |
| Geographic Herfindahl, premiums | 2890.76 | 3065.9 | ** | 3551.32 | 3364.62 |
| Percent unaffiliated companies | 14.0% | 34.9% | *** | 25.1% | 43.4% |
| Percent mutual companies | 2.3% | 15.2% | *** | 13.6% | 34.3% |
| Percent companies with A+ rating | 15.1% | 36.0% | *** | 29.8% | 45.7% |
| Percent companies with A or A- rating | 38.4% | 48.9% | * | 29.9% | 45.8% |
| Percent companies with B+ or B rating | 18.6% | 39.1% | | 18.0% | 38.5% |

Note: Variable values are for one year prior to transaction. Percent change in premiums, t-1 to t is defined as premiums,t divided by premiums, t-1.
***Significant at 1 percent level; ** significant at 5 percent level; * significant at 10 percent level

**Table 5**
**Average Efficiency Scores: Target Versus Non-M&A Firms**

| | | Type of Efficiency | | | | | | Malmquist Index | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | Sample | Cost | Technical | Allocative | Pure Technical | Scale | Revenue | Tech. Eff. Change | Technical Change | TFP Change |
| 1989 | Target | 0.3202 | 0.5533 | 0.6427 | 0.6130 | 0.8739 | 0.2981 | | | |
| | Non-Target | 0.3057 | 0.4883 | 0.6554 | 0.5814 | 0.8364 | 0.3119 | | | |
| | Total | 0.3060 | 0.4896 | 0.6551 | 0.5820 | 0.8371 | 0.3116 | | | |
| 1990 | Target | 0.4526 ** | 0.6800 ** | 0.6391 | 0.6959 | 0.9740 *** | 0.2974 | 2.9780 | 0.8069 | 2.3967 |
| | Non-Target | 0.3385 | 0.5760 | 0.5977 | 0.6273 | 0.9270 | 0.2408 | 1.6099 | 0.7754 | 1.2201 |
| | Total | 0.3424 | 0.5795 | 0.5991 | 0.6296 | 0.9285 | 0.2428 | 1.6538 | 0.7694 | 1.2326 |
| 1991 | Target | 0.4583 | 0.6398 | 0.6997 | 0.6774 | 0.9448 ** | 0.4483 | 1.8909 * | 0.9955 | 1.8716 |
| | Non-Target | 0.3658 | 0.5381 | 0.7000 | 0.5984 | 0.8936 | 0.3714 | 1.1309 | 1.0548 | 1.1531 |
| | Total | 0.3676 | 0.5400 | 0.7000 | 0.6000 | 0.8946 | 0.3730 | 1.1442 | 1.0542 | 1.1674 |
| 1992 | Target | 0.2439 ** | 0.6953 | 0.4554 ** | 0.7840 | 0.8670 | 0.5000 | 3.3385 | 0.9324 | 3.0053 |
| | Non-Target | 0.3469 | 0.5551 | 0.6349 | 0.6244 | 0.8845 | 0.3645 | 1.3490 | 0.8762 | 1.1370 |
| | Total | 0.3460 | 0.5564 | 0.6332 | 0.6259 | 0.8844 | 0.3658 | 1.3660 | 0.8753 | 1.1516 |
| 1993 | Target | 0.3024 | 0.5656 | 0.5535 | 0.6465 | 0.8942 | 0.3137 | 1.1496 | 1.0936 | 1.1894 |
| | Non-Target | 0.3306 | 0.6003 | 0.5599 | 0.6675 | 0.8930 | 0.3553 | 0.9818 | 1.1462 | 1.1164 |
| | Total | 0.3300 | 0.5995 | 0.5598 | 0.6670 | 0.8930 | 0.3544 | 0.9863 | 1.1454 | 1.1189 |
| 1994 | Target | 0.4055 * | 0.6482 | 0.6419 * | 0.7044 | 0.9296 | 0.4667 * | | | |
| | Non-Target | 0.4540 | 0.6471 | 0.7050 | 0.6937 | 0.9291 | 0.3690 | | | |
| | Total | 0.4524 | 0.6472 | 0.7028 | 0.6941 | 0.9291 | 0.3722 | | | |
| All | Target | 0.3839 | 0.6307 ** | 0.6221 | 0.6814 ** | 0.9243 ** | 0.3755 | 2.2412 ** | 0.9450 | 1.9935 ** |
| | Non-Target | 0.3571 | 0.5680 | 0.6419 | 0.6325 | 0.8940 | 0.3361 | 1.2709 | 0.9608 | 1.1568 |
| | Total | 0.3578 | 0.5694 | 0.6414 | 0.6337 | 0.8947 | 0.3370 | 1.2931 | 0.9604 | 1.1759 |

Note: Tech. Eff. is Technical Efficiency; TFP is Total Factor Productivity. ***Significant at the 1% level; **significant at the 5% level; *significant at the 10% level.

**Table 6**
**Regression Models of Changes in Efficiency**

| Variable | Malmquist Indices | | | | | | Efficiency Two Years After/Two Years Before Acquistion | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **TE Change** | | **Tech. Chg** | | **TFP Change** | | **CE** | | **TE** | | **AE** | | **PTE** | | **SE** | | **RE** | |
| Intercept | 3.7256 | *** | 0.7736 | *** | 3.1859 | *** | 3.2757 | *** | 3.6868 | *** | 1.1701 | *** | 3.3447 | *** | 1.1955 | *** | 5.5823 | *** |
| | 0.3868 | | 0.1107 | | 0.3548 | | 0.2737 | | 0.2582 | | 0.1590 | | 0.2188 | | 0.0923 | | 0.7132 | |
| Target Company Dummy | 0.7154 | *** | 0.0295 | | 0.6990 | *** | 0.4422 | *** | 0.3811 | *** | 0.0226 | | 0.3279 | *** | 0.0145 | | 0.8673 | *** |
| | 0.1620 | | 0.0463 | | 0.1486 | | 0.1152 | | 0.1086 | | 0.0669 | | 0.0920 | | 0.0388 | | 0.2995 | |
| Ln(Assets) | -0.0884 | **** | -0.0025 | | -0.0894 | *** | -0.0842 | *** | -0.1080 | *** | -0.0005 | | -0.0956 | *** | -0.0058 | | -0.1727 | *** |
| | 0.0191 | | 0.0055 | | 0.0175 | | 0.0135 | | 0.0128 | | 0.0079 | | 0.0108 | | 0.0046 | | 0.0352 | |
| Mutual | -0.1253 | * | -0.0337 | * | -0.1387 | ** | -0.1341 | *** | -0.0873 | * | -0.0753 | ** | -0.0857 | ** | 0.0026 | | 0.0185 | |
| | 0.0696 | | 0.0199 | | 0.0639 | | 0.0517 | | 0.0488 | | 0.0300 | | 0.0413 | | 0.0174 | | 0.1345 | |
| Geographic Herfindahl (<0) | -0.4368 | *** | 0.0875 | *** | -0.2933 | *** | -0.2829 | *** | -0.4007 | *** | 0.0131 | | -0.3791 | *** | -0.0001 | | -0.6734 | *** |
| | 0.0916 | | 0.0262 | | 0.0841 | | 0.0663 | | 0.0626 | | 0.0385 | | 0.0530 | | 0.9224 | | 0.1728 | |
| Unaffiliated Company | 0.0144 | | -0.0430 | ** | -0.0767 | | -0.0872 | * | -0.0642 | | -0.0303 | | -0.0674 | * | 0.0134 | | -0.1466 | |
| | 0.0654 | | 0.0187 | | 0.0600 | | 0.0473 | | 0.0446 | | 0.0275 | | 0.0378 | | 0.0159 | | 0.1233 | |
| Pct Group Life Premiums | -0.9877 | *** | 0.5170 | *** | -0.3179 | ** | -0.5033 | *** | -0.4004 | *** | -0.1948 | *** | -0.4813 | *** | 0.0433 | | -0.6748 | ** |
| | 0.1786 | | 0.0511 | | 0.1639 | | 0.1314 | | 0.1239 | | 0.0763 | | 0.1050 | | 0.0443 | | 0.3419 | |
| Pct Group Annuity | -0.3994 | ** | -0.1091 | * | -0.2919 | | -0.1633 | | -0.1369 | | 0.0302 | | -0.1257 | | 0.0149 | | -0.5965 | * |
| | 0.2064 | | 0.0591 | | 0.1894 | | 0.1390 | | 0.1311 | | 0.0807 | | 0.1111 | | 0.0468 | | 0.3617 | |
| Pct Indiv.l Annuity Premiums | -0.3907 | *** | 0.0442 | | -0.2672 | ** | -0.0162 | | 0.1077 | | -0.0986 | ** | 0.1018 | | -0.0103 | | 0.2419 | |
| | 0.1192 | | 0.0341 | | 0.1093 | | 0.0860 | | 0.0812 | | 0.0500 | | 0.0688 | | 0.0290 | | 0.2240 | |
| Pct Acc&Health Premiums | -0.3965 | *** | -0.0744 | *** | -0.3291 | *** | -0.5795 | *** | -0.4751 | *** | -0.0997 | *** | -0.3920 | *** | -0.0476 | ** | -0.6576 | *** |
| | 0.0842 | | 0.0241 | | 0.0772 | | 0.0615 | | 0.0581 | | 0.0357 | | 0.0492 | | 0.0207 | | 0.1605 | |
| 1991 Dummy | -0.4725 | *** | 0.3072 | *** | 0.0043 | | -0.1358 | *** | 0.1375 | *** | -0.1944 | *** | 0.0635 | | 0.0614 | *** | -0.2348 | * |
| | 0.0698 | | 0.0120 | | 0.0641 | | 0.0511 | | 0.0482 | | 0.0297 | | 0.0408 | | 0.0172 | | 0.1330 | |
| 1992 Dummy | -0.2531 | *** | 0.1432 | *** | 0.0037 | | 0.2417 | *** | -0.0441 | | 0.1950 | *** | 0.0144 | | -0.0388 | *** | 0.5803 | *** |
| | 0.0701 | | 0.0200 | | 0.0643 | | 0.0514 | | 0.0485 | | 0.0299 | | 0.0411 | | 0.0173 | | 0.1342 | |
| 1993 Dummy | -0.6105 | *** | 0.4073 | *** | -0.0240 | | 0.1739 | *** | 0.1782 | *** | -0.0272 | | 0.1728 | *** | -0.0187 | | -0.7014 | **** |
| | 0.0706 | | 0.0202 | | 0.0648 | | 0.0512 | | 0.0483 | | 0.0298 | | 0.0410 | | 0.0173 | | 0.1335 | |
| Adjusted $R^2$ | 0.1097 | | 0.2740 | | 0.0507 | | 0.1104 | | 0.1040 | | 0.0923 | | 0.1086 | | 0.0213 | | 0.0785 | |
| No. of obs. | 1688 | | 1688 | | 1688 | | 1798 | | 1798 | | 1798 | | 1798 | | 1798 | | 1792 | |

Note: TE Change, and Technical Change are components of the Malmquist Index of TFP. The dependent variable in the remaining equations is KE(t)= efficiency of type K in year t. K=C=cost efficiency; K=A=allocative efficiency; K=T=technical efficiency; K=PT=pure technical efficiency K=S=scale efficiency; and K=R=revenue efficiency. Standard Errors are presented below the estimated coefficients.

*** Significant at 1% level; ** significant at 5% level; * significant at 10% level.

**Table 7**
**Probit Models of the Probability of Acquisition in Year t**

| | Efficiency Variable | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **CE** | | **TE** | | **PTE** | | **AE** | | **RE** | |
| Intercept | 0.7738 | | 0.5690 | | 0.5786 | | 0.4786 | | 0.9821 | |
| | 0.9690 | | 0.9403 | | 0.9363 | | 0.9418 | | 0.9532 | |
| Non-decreasing rts dummy$_{t-1}$ | 0.2456 | * | 0.2541 | ** | 0.2722 | ** | 0.2727 | ** | 0.2290 | * |
| | 0.1317 | | 0.1304 | | 0.1300 | | 0.1305 | | 0.1309 | |
| Efficiency$_{t-1}$ | 0.3092 | | 0.2277 | | 0.3073 | | -0.0399 | | 0.4836 | ** |
| | 0.2708 | | 0.1985 | | 0.1959 | | 0.2472 | | 0.1999 | |
| Pct Change in Premiums(t/(t-1)) | -0.1134 | | -0.1102 | | -0.1116 | | -0.1162 | | -0.1068 | |
| | 0.0724 | | 0.0722 | | 0.0725 | | 0.0731 | | 0.0709 | |
| Net Cash Flow$_{t-1}$/Assets$_{t-1}$ | -0.9080 | ** | -0.8977 | *** | -0.8799 | *** | -0.9319 | *** | -0.9376 | *** |
| | 0.2189 | | 0.2186 | | 0.2198 | | 0.2182 | | 0.2171 | |
| Capital$_{t-1}$/Assets$_{t-1}$ | -0.9026 | ** | -0.8837 | ** | -0.8881 | ** | -0.9380 | ** | -0.8673 | ** |
| | 0.4127 | | 0.4083 | | 0.4067 | | 0.4096 | | 0.4081 | |
| Liquidity Ratio$_{t-1}$ | 0.0376 | | 0.0375 | | 0.0374 | | 0.0373 | | 0.0356 | |
| | 0.0242 | | 0.0240 | | 0.0240 | | 0.0241 | | 0.0244 | |
| Ln(Assets$_{t-1}$) | -0.1288 | *** | -0.1217 | *** | -0.1253 | *** | -0.1104 | ** | -0.1434 | *** |
| | 0.0474 | | 0.0455 | | 0.0453 | | 0.0457 | | 0.0462 | |
| Mutual Dummy | -0.7205 | *** | -0.7123 | *** | -0.7162 | *** | -0.7017 | *** | -0.6868 | *** |
| | 0.2692 | | 0.2679 | | 0.2680 | | 0.2666 | | 0.2705 | |
| Geographic Herfindahl$_{t-1}$ | -0.0001 | *** | -0.0001 | *** | -0.0001 | *** | -0.0001 | *** | -0.0001 | *** |
| | 0.0000 | | 0.0000 | | 0.0000 | | 0.0000 | | 0.0000 | |
| Unaffiliated Company Dummy | -0.3783 | *** | -0.3827 | *** | -0.3951 | *** | -0.3877 | *** | -0.3907 | *** |
| | 0.1408 | | 0.1406 | | 0.1413 | | 0.1408 | | 0.1418 | |
| % Group Life Premiums$_{t-1}$ | -0.0539 | | -0.0271 | | -0.0429 | | 0.0251 | | 0.0307 | |
| | 0.2829 | | 0.2769 | | 0.2764 | | 0.2673 | | 0.2740 | |
| % Group Annuity Premiums$_{t-1}$ | 0.3620 | | 0.3510 | | 0.3243 | | 0.4239 | | 0.2746 | |
| | 0.3905 | | 0.3911 | | 0.3911 | | 0.3855 | | 0.3912 | |
| %Indiv Annuity Premiums$_{t-1}$ | 0.2627 | | 0.2621 | | 0.2573 | | 0.2895 | | 0.2492 | |
| | 0.2126 | | 0.2126 | | 0.2119 | | 0.2103 | | 0.2105 | |
| Pct Acc&Health Premiums$_{t-1}$ | -0.1017 | | -0.1195 | | -0.1228 | | -0.0996 | | -0.1864 | |
| | 0.1634 | | 0.1657 | | 0.1647 | | 0.1634 | | 0.1708 | |
| Log-Likelihood | -364.19 | | -364.17 | | -363.60 | | -364.81 | | -361.75 | |

Note: Standard errors are presented below the estimated coefficients. *** Significant at 1% level; ** significant at 5 percent level; * significant at 10 percent level. Year dummies not shown.

[1]The Glass-Steagall Act prevents banks from entering the insurance business as underwriters, but banks can sell annuity and insurance products manufactured by an unaffiliated insurance company.

[2]Discussions of consolidation in the financial press invariably mention scale economies and efficiency gains as motivating factors in insurer mergers and acquisitions. See, for example, Lonkevich (1995) and Farinella (1996).

[3]We discuss here only those papers that utilize modern frontier efficiency methodologies in studying life insurers.

[4]A more precise discussion of cost and revenue efficiency is provided below.

[5]Although it would be possible to acquire a firm with decreasing returns and shed unprofitable lines of business to achieve optimal scale, it is likely to be less costly to acquire firms that are already scale efficient and require less post-merger integration management than firms that must be significantly restructured.

[6]Although not analyzed here, similar reasoning suggests acquiring firms should tend to display either increasing or constant returns to scale. An acquisition offers the opportunity for a firm with increasing returns to scale to attain constant returns to scale more quickly than by normal sales growth. A firm that is already too large (operating with decreasing returns to scale) would not seem to have much to gain from acquisitions, at least from a cost perspective.

[7]In 1995, 92 percent of the assets in the life insurance industry were controlled by insurance groups, and the balance by unaffiliated single companies.

[8]Insurers traditionally have maintained policy-focused rather than customer-focused data bases, which have been viewed as record-keeping and billing systems rather than as tools to increase sales and improve customer satisfaction. Many insurers have encountered difficulties in attempting to shift to the customer-focused approach.

[9]The agenda also includes accreditation standards for state insurance departments and a new system of regulatory audit-ratio solvency tests.

[10]The risk-based capital ratio is the ratio of an insurer's equity capital to its risk-based capital, which is determined by the characteristics of the insurer's asset and liability portfolios. Insurers with risk-based capital ratios below 200 percent receive additional regulatory scrutiny. Regulators are required to take control of companies with risk-based capital ratios below 70 percent.

[11]See Benston, Hunter, and Wall (1993). They present evidence that earnings diversification provided the motivation for many bank mergers during the 1980s. They reject the hypothesis that bank mergers tend to be motivated by attempts to exploit Federal deposit insurance.

[12]We eliminated firms with negative equity and zero or negative premiums because

such firms are not financially viable market participants and tend to be in receivership or under regulatory supervision.

[13]Insurance groups controlled about 93 percent of industry assets during our sample period.

[14]Both *Best's Insurance Reports*, an annual statistical publication, and *Best's Review*, a monthly magazine also used in our search for mergers and acquisitions, are published by the A.M. Best Company (Oldwick, NJ).

[15]The numbers of firms that were targets for mergers and acquisitions by year were 43, 57, 48, 51, 52, and 66, for the years 1989 through 1994, respectively. This list of target firms does not include those that were found to be internal restructurings of a group or acquisitions of foreign firms.

[16]Because insurers must obtain a license from each state in which they operate, the regulatory costs of starting a new insurer or expanding into new states can be significant. Accordingly, even insurers with no assets or premiums are valuable for their licenses, creating a market in corporate insurance shells. Because the focus of the study is on the acquisition of viable operating entities, shell insurers were omitted from our sample.

[17]Of the 317 M&A targets identified from our examination of *Mergers and Acquisitions*, *Best's*, and the Conning and Company reports, 59 were eliminated from the sample because they were inactive companies, shell companies, or in runoff when acquired; 68 were eliminated because they were merged or retired within two years after the acquisition; 45 were eliminated because they were involved in one or more additional M&A transactions within two years before or two years after the transaction; and 8 were eliminated because the transaction could not be verified in *Best's Insurance Reports.*

[18]In the past, researchers often used premiums as a measure of insurance output. However, this is incorrect, because premiums represent revenues, that is, price times quantity, rather than quantity (Yuengert, 1993).

[19]As a robustness check, we also estimated efficiency for selected years of the sample period using a more highly disaggregated set of output measures. For example, one set of estimates used assets to represent the intermediation function, incurred benefits in the five major lines of business, the number of new and existing policies, and the amount of insurance in force for group and individual life insurance. The resulting efficiency scores were highly correlated with the scores obtained using the five outputs defined in the text. Because having a larger number of outputs tends to increase the time required to estimate DEA and Malmquist efficiencies, we conducted the full set of estimates using the five outputs defined in the text.

[20]Insurers are required to allocate investment income by line in their regulatory annual reports, and we use the reported allocations in defining output prices.

[21]Some companies rely exclusively on agents to distribute their products, others have no agents and market their products through the mail or using telemarketing, while still

others use a combination of agents and other distribution techniques.

[22]A potential problem with this approach is that larger insurers often maintain regional branch offices that perform various administrative tasks. Consequently, as a robustness check, we also conducted the analysis using two additional definitions of the price of home office labor — national average weekly wages for SIC class 6311 and state weighted-average weekly wages, using as weights the proportion of an insurer's premium writings in each state. The use of these alternative labor price variables did not materially affect the results.

[23]As a robustness check, we also conducted the analysis using the insurers' reported average return on book equity over the three years prior to each sample year. Using this alternative cost of capital measure did not materially affect the results.

[24]Cummins and Zi (1998) find rank correlations or around 0.67 between the efficiency scores produced by DEA and those obtained from econometric models.

[25]We also drop the subscript i to conserve notation, but the optimization is still understood to be for a specific firm.

[26]Because our Malmquist productivity index is input-oriented, the numerator and denominator are reversed compared with those in Färe et al. (1994), in which they use output-oriented Malmquist index.

[27]Because mutuals are owned by their policyholders and do not issue shares of stock, mutual acquisitions are usually accomplished using "guarantee capital certificates." These are in reality debt instruments that are subordinated to insurance loss claims against the company. However, for regulatory purposes they are treated as equity. The use of these "surplus notes" is tightly regulated, and mutual acquisitions in general receive much more stringent regulatory scrutiny than stock company acquisitions.

[28]We also analyzed the data using a benchmarking approach, which consisted of matching each target firm with ten firms from the non-M&A sample that were similar to the target firm in terms of size. Again, however, differences between the mean efficiencies and efficiency changes of the target and non-M&A benchmark samples generally were not statistically significant. We conclude from this result that the benchmarking approach does not adequately control for differences among firms that may be obscuring any differences in efficiency between the target and non-M&A firms. This emphasizes the importance of conducting the multiple regression analysis discussed in the following section.

[29]The technical efficiency ratio TE(t+2)/TE(t-2) provides an alternative to the Malmquist index of technical efficiency change as a measure of changes in this type of efficiency.

[30]Evidence that mtuual property-liability insurers are involved in less complex and less risky activities is provided by Mayers and Smith (1988) and Lamm-Tennant and Starks (1993).

[31]We conducted robustness checks by estimating models based on a sample that also included firms that were merged or retired following the transaction. The results were not materially affected by pooling the merged and acquired firms. Although we also conducted the analysis only with the merged firms, the number of merged firms for which we have valid data (18 in total) is too small to support any separate conclusions.