Mergers & Acquisitions in the U.S. Property-Liability Insurance Industry: Productivity and Efficiency Effects

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Abstract

This paper analyzes the productivity and efficiency effects of mergers and acquisitions (M&As) in the U.S. property-liability industry during the period 1993-2003 using data envelopment analysis (DEA) and Malmquist productivity indices. We seek to determine whether M&As are primarily driven by value-maximizing versus non-value-maximizing objectives. The analysis examines efficiency and productivity change for acquirers, acquisition targets, and non-M&A firms; and we also examine the firm characteristics associated with becoming an acquirer or target through probit analysis. The results indicate that M&As in property-liability insurance were primarily associated with value-maximization. Acquiring firms achieve more revenue efficiency than non-acquiring firms, and target firms experience greater cost and allocative efficiency growth than non-targets. Financially vulnerable insurers are significantly more likely to become acquisition targets, consistent with corporate control theory, and we also find evidence that M&As are motivated by earnings diversification, but there is no evidence that scale economies played an important role in the insurance M&A merger wave.

JEL Classification: G22, G34

Keywords: Mergers and Acquisitions; Property-Liability Insurance; Productivity and Efficiency; Malmquist; Data Envelopment Analysis (DEA)

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1. Introduction

In the 1990s, the property-liability (P-L) insurance industry in the United States experienced an unprecedented wave of mergers and acquisitions (M&As). As in other segments of the financial services industry, the M&A wave was driven in part by changing technologies, particularly advances in computing and communications, that changed the optimal scale of technology development projects and put a premium on firms that were relatively advanced technologically. P-L insurance M&As also were driven in part by changing risk levels in the industry, particularly the increase in catastrophic risk and the risk of liability lawsuits (Cummins, 2006; Graham and Xie, 2005). Unlike banking, however, deregulation did not play a role in the P-L insurance M&A wave. In fact, the major regulatory change in P-L insurance in the past fifteen years was the introduction of regulatory risk-based capital (RBC) standards in 1994. RBC motivated some M&As as stronger firms acquired financially vulnerable firms that would have incurred significant capital costs in responding to RBC regulations (Conning, 1995).

The usual arguments about the causes of the P-L insurance M&A wave suggest that insurance M&As may have resulted in productivity and efficiency gains in the P-L industry. The purpose of this paper is to explore the efficiency and productivity effects of insurance M&As and to shed light on the motivations for M&As by analyzing the probability of firms' being involved in M&A activity as a function of firm characteristics. The analysis investigates two primary hypotheses about the effects of M&As on targets and acquirers – (1) the value maximization or synergy hypothesis, and (2) the hypothesis that M&As are primarily driven by non-value maximizing behavior by managers. Value maximizing motivations include achieving economies of scale and scope, improving X-efficiency, gaining market power, achieving earnings diversification, and improving other aspects of financial performance (e.g., Berger, DeYoung, and Udell, 2001; Amel, et al., 2004; Lambrecht, 2004). Non-value maximizing motivations include various agency theory explanations such as managerial hubris, empire-building, increasing managerial compensation, and expense preference behavior.

This paper provides evidence on whether M&As in the U.S. P-L industry tend to be value maximizing or non-value maximizing by measuring the effects of M&As on the efficiency and productivity of target and acquiring firms. If M&As are primarily motivated by value-maximizing factors and if mergers succeed in achieving their goals, we expect to observe improvements in efficiency and productivity. Moreover, by analyzing the firm characteristics associated with being a target or acquirer, using probit analysis, we can shed light on the factors that motivate M&A transactions.

The efficiency and productivity effects of the M&A wave in the P-L insurance industry have not previously been investigated. This paper investigates the effects of consolidation through a dynamic analysis of insurer efficiency and productivity using data envelopment analysis (DEA) and Malmquist indices, respectively. Specifically, we examine the relationship between M&As, efficiency, productivity, and scale economies during the period 1993-2003. This is the first paper to use frontier efficiency and productivity analysis to study the M&As in the U.S. P-L insurance industry. Previous work on M&As in this industry does not consider the efficiency or productivity effects of consolidation (Chamberlain and Tennyson, 1998; BarNiv and Hathorn, 1997; Meador, Madden, and Johnston, 1986). There has been one prior paper on the efficiency effects of M&As in the U.S. life insurance industry. Using a methodology similar to that applied in the present paper, Cummins, Tennyson, and Weiss (1999) find that target life insurers achieve greater efficiency gains than firms that have not been involved in M&As and that financially vulnerable insurers are more likely to be acquired.

The frontier efficiency analysis methodology utilized in this paper summarizes the overall performance of a firm into one score that takes into account the multi-dimensional production process of the firm. Firms in the sample are compared to "best-practice" production, cost, and revenue frontiers consisting of the dominant firms in the industry. Firms operating on the frontiers are considered fully efficient (with efficiency scores equal to 1), whereas firms not operating on the frontier are inefficient (with efficiency scores between zero and 1). The DEA methodology used to measure efficiency in this paper is a non-parametric technique that has been widely used in many branches of economics (Cooper, Seiford and Tone, 2000). It has a number of advantages over alternative approaches, as explained below. To measure productivity, defined as shifts in the frontier over time or changes in the efficiency of firms relative to the frontiers over time, we utilize Malmquist index analysis, also a non-parametric technique that is closely related to DEA (e.g., Grosskopf, 1993; Ray and Desli, 1997).

The frontier approach utilized in this paper is a different but complementary methodology to two widely used alternative approaches to analyzing M&As – event studies and cash flow analysis. The event study approach looks at the stock price performance of M&A targets and acquirers surrounding the merger to gauge the stock market's reaction to the transaction. Because most takeover targets in the P-L insurance industry are not publicly traded and some companies withdraw from public listing following takeover, the DEA approach used in this paper adds value by being able to study both traded and non-traded firms. Cash flow analysis uses accounting data to check the post-merger cash flow performance of acquirers and targets, and explores sources of merger-induced changes in cash flow performance (e.g., Cornett and Tehranian, 1992; Healy, Palepu and Ruback, 1992). The DEA and Malmquist analysis can add more information than cash flow analysis by taking into account the multidimensionality of the firm's production process. Efficiency and productivity analysis also provide further evidence on whether firms really benefit from M&As and whether the changes in efficiency and productivity correlate with the underlying motivations for M&As.

By way of preview, we find significant improvements in revenue efficiency for acquiring firms, consistent with gains from economies of scope, and also find significant gains in cost efficiency for targets, providing evidence that M&As lead to synergies. Firms involved in M&As are not significantly different from non-M&A firms in terms of total factor productivity growth, after controlling for other firm characteristics in a multiple regression analysis. Larger firms and firms with relatively high returns on equity are more likely to be acquirers, and financially vulnerable firms are more likely to be targets. Overall, the results are consistent with the hypothesis that M&As are driven by value-maximizing motives.

The remainder of the paper is organized as follows. Section 2 discusses various motives for takeovers and specifies hypotheses on M&As. Section 3 discusses our databases on firm characteristics and M&As and discusses sample selection for M&A targets and acquirers. Section 4 describes our methodology for efficiency and productivity analysis. Section 5 presents the estimation results of efficiency and productivity change, and section 6 identifies the probability that firms become acquirers or targets using probit analysis. Section 7 concludes.

2. Hypotheses Formulation

In this section, we discuss motivations for takeover activities and formulate hypotheses about the effect of takeovers on the efficiency and productivity of firms. In addition to discussing the rationale for M&As, we also develop hypotheses about firms' characteristics that are likely to be associated with their probabilities of being M&A targets or acquirers.

We measure the performance of a firm by its technical efficiency, scale efficiency, cost efficiency, and revenue efficiency, as well as by its productivity gains over time, as measured by Malmquist indices. If M&As are motivated by opportunities to improve a firm's performance and if managers succeed in accomplishing their objectives, we should observe improvements in efficiency or productivity of the target firm and/or the combined post-merger entity. If M&As are motivated by non-value maximizing factors or if post-merger integration is unsuccessful, then the merger activity may lead to reduced efficiency and productivity losses.

2.1. Economies of scale and scope

Perhaps the most frequently cited rationale for a takeover is economies of scale – a firm expands to obtain optimal operating scale and thereby reduce average unit costs of production. The usual source of cost scale economies is the spreading of fixed costs over a broader output base. For insurance firms, important fixed costs include computer systems and software development costs. The actuarial, underwriting, and investment operations of insurers also have fixed cost components that can be sources of scale economies. Another source of scale efficiency that is expected to be particularly important for insurers is earnings diversification (Cummins, Tennyson and Weiss, 1999). The basic principle of insurance is "the law of large numbers," which holds that expected losses become more predictable as the size of the insured pool increases. Enhanced predictability implies that large insurers have less volatile earnings and thus need to hold less equity capital per policy underwritten, providing a potentially powerful source of cost reduction. Increasing underwriting diversification also may permit insurers to engage in higher risk, higher return investment strategies without increasing their costs of capital or probability of financial distress. M&As enable insurers to expand their pool of policyholders and reduce underwriting risk more rapidly than is usually possible through organic growth.

If economies of scale provide an important motivation for M&As, the performance of the target and/or combined firms will be improved after M&As because of the effect of scale economies. If firms seek scale economies through M&As, another prediction is that firms operating with increasing or constant returns to scale (IRS or CRS) are more likely to be takeover targets than firms operating with decreasing returns to scale (DRS), because DRS firms are already "too large" to be scale efficient. However, there is no special reason to believe that acquirers will be scale efficient. Size is an advantage in being an acquirer, and many large firms are not scale efficient (Cummins and Xie, 2005).

Achieving economies of scope is another motivation often given for M&A transactions. Cost scope economies can arise if a firm can reduce overall production costs by providing different types of products or engaging in a range of activities, rather than specializing in fewer products or activities. Examples often given are gains from exploiting shared resources such as customer lists, brand names, managerial talent, information technology, or customer service capabilities. Revenue economies of scope arise if customers prefer to deal with firms that provide several types of financial services due to reduced search costs and other factors that create preferences for "one-stop shopping." If M&As enable firms to achieve economies of scope, mergers that result in increased geographical or product line diversification are expected to lead to higher efficiency or productivity gains than focusing mergers.

2.2. Corporate control theory and M&As

Corporate control theory (e.g., Jensen, 1988; Shleifer and Vishny, 1988) argues that takeover is an efficient means to replace inefficient and non-value-maximizing incumbent managers of target companies. The target firm may underperform either because its managers pursue their own interests at the expense of owners' interests by engaging in non-value maximizing behavior or because they lack the knowledge and skills to maximize firm value. If managers of acquiring firms are more capable than those of acquired firms, they can employ new production technologies, achieve better resource allocation, and generally improve the efficiency of targets. This theory predicts that poorly performing firms are more likely to be acquired and that the performance of targets will improve after the takeover. Acquiring firms are also expected to gain from the takeover activity to the extent that acquirers have the capability to bring operating synergy to the post-takeover combined entity.

On the other hand, there is some evidence in the insurance industry that acquirers might prefer efficient targets, especially firms that possess competencies in certain areas or product lines that could bring the aggressive acquiring insurers market power and more cost and revenue efficiency (Cummins, Tennyson, and Weiss, 1999). Therefore, we do not have a clear prediction on whether the targets are relatively more or less efficient than non-targets.

2.3. Financial synergy and M&As

M&As also can be motivated by financial synergies. Financial synergy theory argues that, with asymmetric information in financial markets, a firm with insufficient liquid assets or financial slack may not undertake all valuable investment opportunities (Myers and Majluf, 1984). In this case, the firm can increase its value by merging with a slack-rich firm if the information asymmetry between the two firms is smaller than that between the slack-poor firm and outside investors. By merging with a slack-rich partner, the slack-poor firm does not have to forgo attractive investment opportunities because of the high costs of raising external capital. A slack-rich firm can also increase its value by the investment opportunities brought about by the merger. Thus, takeover may be an efficient means to alleviate information asymmetries and achieve financial synergies. This theory predicts that firms in financial distress but with good investment opportunities are more likely to be involved in M&A activities, either as targets or as acquirers.

Raising capital from external capital markets can be difficult for financially distressed insurers, especially mutuals or private stock companies with limited ability to raise new capital quickly. These insurers also face substantial transactions costs when raising new capital, due to market inefficiencies and information asymmetries. Outside investors generally have less information about the quality of an insurer's assets and the true value of its reserve estimates for unpaid losses, especially for long-tail lines such as commercial liability insurance. Outside investors therefore may tend to charge a higher premium for their investments in such insurers, making it even less attractive for insurers to raise new capital from external capital markets (Chamberlain and Tennyson, 1998). If the information asymmetry between the acquiring firms and target insurers is less than the asymmetry between the targets and capital markets, financially sound firms will seek to acquire firms that are financially weak but have attractive growth opportunities. If the financial synergy between acquirers and targets dominates other motivations, we should find efficiency or productivity improvements for either the targets or combined firms.

2.4. Agency cost and M&As

The agency cost theory of M&As argues that takeover activity often results from acquiring firm managers' acting in their own self-interests rather than in the interests of the firm's owners (e.g., Shleifer and Vishny, 1988 and 1989). Mangers may be motivated to increase their compensation by increasing the size of the firm through non-value maximizing mergers or engaging in "expense preference" behavior by over-consumption of perquisites. Managers also may intentionally acquire businesses that require their personal skills in order to make it costly for shareholders to replace them. To the extent that M&As are primarily motivated by managerial self interest, they are unlikely to generate operating or financial synergies that lead to improvements in efficiency or productivity.

The managers of target firms are likely to resist takeover because of the threat to their job security. Although resistance is likely to be present among managers of insurance groups as well as mangers of unaffiliated single companies, resistance is likely to be stronger among managers of unaffiliated firms. The managers of an unaffiliated company face an uncertain future if their firm is acquired by another firm and, as a result, are likely to be more resistant to takeover offers. Managers of insurance groups, on the other hand, are more likely to view the purchase and sale of 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 or that they may be replaced if their firm is acquired, the risk to their job security is likely to be less than the threat that a buy-out poses to managers of an unaffiliated firm. Thus, we hypothesize that unaffiliated firms are less likely to be takeover targets than companies that are part of insurance groups.

2.5. Managerial Hubris hypothesis and M&As

The managerial hubris hypothesis argues that, even if managers try to maximize the value of the firm, they might overestimate the value of what they buy because of hubris (Roll, 1986). This is particularly true in waves of consolidation, when managers blindly follow the markets and change their beliefs on conglomeration versus strategic focus or when multiple bidders compete for the same target. Managers also could underestimate the cost of post-merger integration or overestimate their ability to control a larger institution. As a result, a purchase or a sale that is believed to benefit the acquirer could simply be a poor strategic decision where benefits are overestimated or costs are underestimated.

2.6. Industry shock theory and M&As

Industry shock theory holds that M&A activities within an industry are not merely firm-specific phenomena but the result of the adaptation of industry structure to a changing economic environment or "industry shocks" such as changes in regulation, changes in input costs, increased foreign or domestic competition, or innovations in technology (Mitchell and Mulherin, 1996). Mitchell and Mulherin (1996) argue that corporate takeovers are the least costly means for an industry to restructure in response to the changes brought about by economic shocks but that post-takeover performance of firms should not necessarily improve, especially when compared to a pre-shock benchmark or to the industry average.

The P-L insurance industry of the United States experienced hard times in the early 1990s.

Depressed premium rates, record catastrophe losses (Hurricane Andrew in 1992 and the Northridge Earthquake in 1994), and poor stock price performance of the industry forced a number of weaker insurers to merge with willing acquirers (Conning, 1995). In addition, the adoption of the regulatory risk-based capital (RBC) system in 1994, designed to raise capital standards in the industry and improve solvency of insurers, forced some relatively weak insurers to find a way out of financial distress to avoid incurring regulatory costs. M&As provide these companies a convenient tool to restructure their operations and survive the shocks.

Although a shock to an industry can impact all firms in the industry, firms with smaller size, relatively low growth prospects, higher insolvency risk, or vulnerable capital structures are believed to be more affected by shocks than financially healthier firms. Therefore, we hypothesize that financially vulnerable firms are most likely to become takeover targets. The efficiency of targets/combined firms will not necessarily improve if these acquisitions are linked to an industry shock to the target or acquirers.

2.6. M&A Hypotheses: Discussion

The rationales for M&As discussed above are not necessarily independent or mutually exclusive. In many cases, different motivations and objectives work interactively to bring about an M&A deal. For example, during a period of shock, the firms that are more vulnerable to the shock are generally poorly performing firms. Moreover, some hypotheses have similar implications for the effect of acquisitions on the efficiency changes of M&A firms, and it might be difficult to disentangle them. However, the analysis does enable us to identify whether the value-maximizing or non-value maximizing behavior is the dominant explanation.

Compared to target firms, it is more difficult to identify the characteristics of acquiring firms. They might be efficient or financially healthy firms, but they could also be large and less efficient firms if their managers believe in the idea of "too big to fail" or if managerial self interest prevails. During times when "leveraged buyouts" are prevalent, acquiring firms may also be financially poor firms with relatively attractive growth opportunities, which may buy out firms with a lot of slack but few investment opportunities, in order to seek financial synergies.

3. Data and Sample Selection

This section discusses our data sources as well as the selection of the sample of M&As to include in the analysis. It also specifies the two samples utilized to estimate efficiency and productivity – (1) the insurance group and unaffiliated single company sample, and (2) the insurance company samples consisting of unaffiliated single firms and affiliates of groups.

3.1. Data Sources

Our M&A data come from two sources: (1) Conning & Company for the period 1994 through 1996, and (2) the SNL DataSource for the period 1997 through 2003.[1] The Conning and SNL databases are preferable to more generic databases such as Thomson Financial's SDC database because Conning and SNL focus on the insurance industry and conduct independent research to track M&A transactions for both traded and non-traded insurers. Because SNL is somewhat more complete than Conning, we rely on SNL during the years when this database was available. The financial data required to estimate efficiency and productivity and to test our hypotheses are taken from the regulatory annual statement database maintained by the National Association of Insurance Commissioners (NAIC). Supplementary data were obtained from various publications of the A.M. Best Company, an insurance financial ratings firm.

3.2. Sample selection: Targets and acquirers

To be consistent with takeover theories, where a takeover must involve a change in the ownership of a firm, we exclude from our sample the M&A deals that are pending, terminated, or non-binding, as well as acquisitions of a minority interest. Acquisitions of lines of business that did not involve a change in the ownership of firms are also excluded. The resulting sample consists of 588 cases representing

[1] The SNL DataSource is provided by SNL Financial Corporation, http://www.snl.com.

complete acquisitions and acquisitions of a majority interest over the period 1994-2003.[2]

As discussed below, in order to estimate changes in productivity and efficiency following M&A transaction, we require complete financial data on all firms included in the analysis for the year prior to each transaction and the two years following the transaction. In addition, because most of the hypotheses focus on the effects of a transaction on the target or acquirer, we need to focus on cases where the target changes ownership but remains an independent entity. Some target firms were eliminated from the sample for other reasons, primarily relating to data availability, as discussed below. These criteria resulted in an unavoidable reduction in the final sample size to 149 target companies, for which estimation of productivity and efficiency change over the window from the year prior to the transaction to the second year following the transaction, is feasible. However, because of the careful consideration given to selecting the sample, we are confident that the final sample consists of those target firms that continued as viable operating entities following the merger and have all of the necessary financial data to conduct the analysis.

There were various criteria applied in sample selection that led to the elimination of some M&A transactions. We had to exclude deals whose targets are foreign companies (98 deals) because such firms do not file data with the NAIC. Also excluded were deals whose targets could not be verified in *Best's Insurance Reports* and the NAIC annual statement files (64 deals),[3] or if the target is a title insurance company (30 deals).[4] An additional 19 deals were excluded because the target merged fully with the acquirer so that its independent financial data is not available after the merger. We further exclude 175 target companies either because the deal represented the internal restructuring of an existing insurance group or because the target was inactive, in run-off, retired after the acquisition, or was involved in another transaction within two years before or after the recorded transaction.

Twenty-three target companies are excluded because the target was a Lloyds' association, captive, or a state fund worker's compensation program, or because the target firm was acquired as a shell company.[5] Some target companies were lost because they have 100% reinsurance arrangements with their parent companies or other companies, i.e., they are not fully functioning insurance underwriting operations, and we further lose some observations when performing the efficiency analysis because complete data are not available one year prior to two years after the acquisition. The final sample for estimating productivity change for this window is 149 firms.

The sample selection criteria for acquiring firms are as follows. First, only firms that are insurance companies and report data to the NAIC are selected, as identified from the NAIC annual statements and *Best's Insurance Reports*. Second, only acquirers whose targets are valid cases in our sample as described above are kept. And, third, acquirers involved in more than one M&A transaction within a year are only counted once. Accordingly, we identify a sample of 187 acquirers over the period 1994-2003, the overwhelming majority of which are groups. We further exclude acquirers that are also sellers or purchase firms that do not meet our target selection criteria in the same transaction year. The final sample available for estimating productivity change of one year prior to two years after acquisition is 96 firms.

3.3. Sample selection: Efficiency estimation

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[2] A deal is counted as a P-L M&A deal if the target is a P-L insurance company, as defined by the source of the majority of a firm's premium income. Because some transactions involve targets that are insurance groups consisting of several affiliated companies, the sample includes 806 target companies.

[3] We use the NAIC insurance group definitions, so a target must be identified as affiliated with a specific group or as an unaffiliated firm either in the NAIC annual statement database or *Best's Insurance Reports*.

[4] Title insurers are relatively small and highly specialized and thus are not representative of the mainstream property-liability insurance industry.

[5] Lloyds' associations in the U.S. are not affiliated with Lloyds' of London but rather are a somewhat unusual organizational form primarily consisting of small firms domiciled in Texas. Captives are firms owned by non-insurance corporations that primarily or exclusively insure the risks of the parent firm. State workers' compensation funds are state-run firms that exist in a few states primarily to supplement the private market for workers' compensation insurance. These firms are not representative of the mainstream property-liability insurance industry.

To compute efficiency estimates, we need to include both M&A firms and firms that are not involved in M&A activity during the sample period. Both M&A firms and non-M&A firms compete directly in insurance markets, so excluding the non-M&A firms would not give accurate estimates of the efficient frontiers. Two samples of firms are used in the efficiency and productivity estimation: (1) A sample of group-affiliated and unaffiliated insurance companies is used to estimate efficiencies for purposes of analyzing target companies. This is referred to as the *company sample*. Individual companies are used for this analysis because individual firms rather than groups are often the targets in M&A transactions and because groups, when they are acquired, usually cease to exist. (2) A sample of groups and unaffiliated single companies is used to measure changes in efficiency and productivity for acquirers. In this case, we are interested in measuring whether the acquiring entity as a whole registered gains in efficiency or productivity as the result of M&A transactions, in comparison with groups and unaffiliated firms not involved in M&As. This is referred to as the *group and unaffiliated firm sample.*

The data for both samples are drawn from the regulatory annual statements filed by insurers with the NAIC. The statements are filed at the company level even for members of insurance groups. For the group and unaffiliated firm sample, the group-affiliated companies are aggregated to the group level using the NAIC group definitions. Our original database consisted of virtually all affiliated and unaffiliated companies in the industry. We excluded firms with abnormal characteristics such as zero or negative net worth, premiums, or inputs, and firms with unrealistic premiums-to-surplus ratios. Such firms are experiencing financial difficulties or have nearly 100% reinsurance arrangements with other companies. Risk retention groups, Lloyds' associations, state worker's compensation funds, and firms whose organizational forms are not recognized in Best's and the NAIC files are also excluded. The final company sample consists of approximately 1,550 firms per year, representing about 83.1% of the industry's assets; and the final group and unaffiliated firm sample consists of approximately 800 firms per year, representing 87.2% of the industry assets.

4. Methodology

This section presents our estimation methodology. The sections begins with a discussion of the measurement of outputs, inputs, and prices, followed by a discussion of the DEA and Malmquist methodologies used in estimating efficiency and productivity. The section concludes with a discussion of the efficiency-productivity estimation window.

4.1. Outputs and output prices

In keeping with most of the recent banking and insurance literature (Berger, Demsetz, and Strahan, 1997; Cummins and Weiss, 2000), we measure outputs of insurance firms using the value-added approach, which considers all asset and liability categories that have significantly value-added components as important outputs, as judged using operating cost allocations (Berger and Humphrey, 1992). Property-liability insurers provide three principal services: risk pooling and risk bearing, real financial services relating to risk management and insured losses, and financial intermediation services.

We proxy the quantity of P-L insurance output by the present value of losses incurred (Cummins and Weiss, 2000).[6] Losses incurred measures the total amount of losses expected to be distributed by the insurers as a result of their providing insurance coverage for a given year, so it is a good proxy for the amount of risk pooling conducted, and losses are also a good proxy for the quantity of real services since such services are highly correlated with aggregate losses. Because the lines of P-L insurance differ in risk characteristics and payout schedules, we group together lines with similar characteristics. Specifically, four insurance outputs are utilized, all based on the present value of losses incurred, for personal lines short-tail coverages (PST), personal lines long-tail coverages (PLT), commercial lines short-tail coverages (CST), and commercial lines long-tail coverages (CLT). The tail refers to the length of loss payout period, as defined by Schedule P of NAIC regulatory statements. The loss payout for each line is calculated from Best's Aggregates and Averages using the chain-ladder method, a widely accepted actuarial technique (Lemaire, 1985). Losses are discounted using U.S. Treasury yield curves released by

[6] We use the term losses incurred to refer to the total of losses and loss adjustment expenses incurred.

the Federal Reserve Board of Governors. A fifth output, for the quantity of intermediation services, is measured as the average of a firm's beginning and end-of-year invested assets. All outputs are deflated to real 2000 values using the Consumer Price Index (CPI).

We define the price of each insurance output as the difference of real premiums earned and the real present value of losses incurred for the output divided by the real present value of losses incurred. This approach is consistent with the concept of the risk premium for insurance services and provides a measure of value-added in each line. Because insurance premiums reflect the discounted value of expected future loss and expense payments, losses must be discounted in order for the revenue and output elements of the insurance price measure to consistently reflect present value concepts.

The price of the intermediation output is defined as the expected return on invested assets. Stocks and other invested assets are treated separately for purposes of measuring the expected returns, where other invested assets primarily consist of bonds, notes, and other interest bearing securities. The expected return on stocks for a given year is the average 30-day Treasury bill rate at the end of the preceding year plus the long-term (1926 to the end of the preceding year) average market risk premium on large company stocks from Ibbotson Associates (2005). The price for other invested assets is their realized income return for the year, since the expected return is generally close to the actual income return. The price of intermediary output is obtained by taking a weighted average of the expected returns on stocks and other invested assets, with the weights equal to the proportion of assets invested in stocks and other assets, respectively.

Losses incurred reflect the insurers' best estimates of expected loss payments for each coverage year, calculated at the end of the year, and consist of losses paid for that year's coverage during the year plus reserves for losses to be paid in the future. Losses incurred inevitably do not equal expected loss estimates that went into calculating the premiums for the coverage year because losses are random and loss realizations generally are more or less than the expected value of loss. This does not necessarily reflect a problem in accurately measuring output, because insurers have actually provided more (less) output than anticipated if losses are higher (lower) than expected. Nevertheless, the randomness does create a potential "errors in variables" problem in the measurement of output prices. Although such problems are less serious for non-parametric methods such as DEA than for parametric estimation methods, we elected to apply a smoothing procedure to the output series as a way of correcting for errors in variables.

The need for smoothing became apparent on inspection of the insurance output prices, where we noticed some price ratios which were apparent outliers. On further analysis, we discovered that these primarily occurred for companies that had very small market shares, such that actual losses could be much higher or lower relative to premiums because of the relative lack of diversification for these firms. Accordingly, we implemented a smoothing procedure, which was applied separately for each firm to the four insurance outputs and their prices. The procedure is defined in the Appendix.

We believe that the smoothed prices and outputs used in the present study are an improvement on those used in the prior literature on P-L insurance efficiency, because smoothing resulted in somewhat less noisy efficiency estimates. However, the efficiency results with the smoothed and raw series were quite similar and provided comparable efficiency rankings for the firms in the sample. For example, for the group and unaffiliated firm sample, the correlation of efficiencies based on the smoothed and raw losses and prices are 0.94 for technical efficiency, 0.94 for scale efficiency, 0.94 for allocative efficiency, 0.94 for cost efficiency, and 0.84 for revenue efficiency. The correlations for the company sample are similar. Moreover, regressions based on efficiencies estimated using unsmoothed losses and prices support the same conclusions as those based on the smoothed losses and prices.[7]

4.2. Inputs and input prices

Insurance inputs are classified into four groups—administrative (home office) labor, agent labor, materials and business services (including physical capital), and financial equity capital. We measure the current price of administrative labor using the U.S. Department of Labor (DOL) average weekly wage

[7] The results based on the unsmoothed losses and prices are available from the authors.

rate for property-liability insurance companies (Standard Industrial Classification (SIC) 6331 before 2001 and North American Industry Classification System (NAICS) 524126 since 2001). The current price of agent labor is measured using the U.S. DOL average weekly wage rate for insurance agents (SIC 6411 and NAICS 524210 since 2001). National average weekly wage rates are used here to reduce missing observations.[8] All of the wage variables are deflated to real 2000 values by the CPI to obtain the real prices of the inputs. The current price of the materials and business services input is calculated as a weighted average of price indices for business services from the component indices representing the various categories of expenditures from the expense page of *Best's Aggregates and Averages*. The base year of the price index is 2000. The relevant price indices also are from the U.S. DOL.

Since data on the number of employees or hours worked and materials used in the insurance industry are not available, we impute the input quantity of an insurer from the dollar value of related expenses, i.e., the quantity of an input is defined as the current dollar expenditures related to this input divided by its *current* price. Because the prices are all deflated to 2000, the product of price and quantity is the constant dollar expenditure on each input.

Our final input is financial equity capital, which is considered an important input in modern financial theory (Berger, Cummins, and Weiss, 1997; Hughes and Mester, 1998). Insurance companies must maintain equity capital to meet regulatory requirements and to ensure payment to policyholders if claims are larger than expected. In fact, the amount of capital held by most insurers is far in excess of the regulatory requirement, indicating a market demand for levels of financial strength higher than required by regulators. The quantity of this input is measured by the average of the beginning and end-of year equity capital level, deflated by the CPI. The ideal cost of capital measure is the expected market return on equity capital. However, expected market returns cannot be calculated for most insurers because the majority of them are not publicly traded. A good proxy for the expected return on equity is the size adjusted capital asset pricing model expected return, based on data from Ibbotson Associates (2005). The cost of capital for year t is calculated as the 30-day Treasury bill rate at the end of year t-1, plus the long-term (1926 to the end of year t-1) average market risk premium on large company stocks, plus the long-term (the 1926 through end of year t-1) average size premium by size category from Ibbotson Associates.[9] We follow Ibbotson in grouping the insurers in our sample into four size categories based on equity capital.[10] The largest size category has no size premium. For the three smaller size categories, the Ibbotson long-term average size premium for each size quartile is added to the large firm expected return to give the price of the financial capital input.[11]

4.3. DEA and Malmquist Estimation Methodology

We use the DEA approach to estimate efficiency and use the Malmquist index, which is also DEA-based to measure the productivity change. DEA is a nonparametric methodology that has been used extensively in a variety of industries (e.g., Cooper, Seiford and Tone, 2000). Compared to other efficiency estimation approaches, such as econometric approaches, DEA has the following merits: (1) It avoids the

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[8] Some studies (e.g., Cummins and Nini, 2002) use the home state wage rate for administrative labor and the state-weighted average weekly wage rate for agent labor. Cummins, Tennyson, and Weiss (1999) conduct robustness tests for all three types of wages rate in U.S. life insurance industry and conclude that the alternative wage variables do not materially change the results.

[9] Using this approach implicitly assumes that insurers have equity portfolios with market betas of 1.0. This is reasonable given that insurers are conservative investors.

[10] We first rank the firms in the sample by size decile based on equity capital. Because market values are not available for the majority of insurers, the size rankings are based on book values of equity capital. Firms are then placed into the following four categories, following Ibbotson (2005): large-cap = deciles 1 and 2 (the largest size deciles), mid-cap = deciles 3 through 5, small-cap = deciles 6 through 8, and micro-cap = deciles 9 and 10. The cost of capital is then calculated as: $R_{it} = R_{f,t-1}$ + Risk Premium_{t-1} + Size $\text{Premium}_{i,t-1}$, where R_{it} = cost of capital for firm i in year t, and Size $\text{Premium}_{i,t-1}$ = the size premium for firm i based on the capitalization category of the firm.

[11] We also estimated efficiencies omitting the size premium and assigning the same cost of capital to each firm in a given year. The results were similar and did not change the overall conclusions. Robustness checks using other cost of capital measures reveal that efficiencies are generally robust to this assumption (Cummins and Weiss 2000).

choice of a specific functional form for the technical, cost, or revenue function and requires no distributional assumptions. Such assumptions can create specification errors, with unknown effects on the efficiency estimates. (2) DEA is individual-firm based, making it easy to identify efficiency and productivity changes by firm, which is particularly convenient for studying M&As. And (3) it provides a convenient way to decompose cost and revenue efficiency into their pure technical, scale, and allocative components.

In addition to its convenience and the avoidance of assumptions about functional form and probability distributions, the DEA approach also has good statistical properties. First, as shown in Banker (1993), DEA is equivalent to a maximum likelihood estimation, with the specification of the production frontier in DEA as a nonparametric monotone and concave function instead of a parametric form linear in parameters. Second, DEA estimators are consistent and converge faster than estimators from other frontier methods (Kneip, Park and Simar, 1998; Grosskopf, 1996). Third, DEA estimators are also unbiased if we assume that there is no underlying model or reference technology. If one believes in an underlying model, then the problem of bias in DEA estimator arises, but this bias deceases with sample size (Kittelsen, 1995).

4.3.1. DEA efficiency estimation

We use the DEA method to estimate efficiency, including pure technical, allocative, scale, cost, and revenue efficiency of firms. Pure technical efficiency measures the success of firms in adopting the "best practice" technology, while scale efficiency measures the success of firms in achieving constant returns to scale. The product of pure technical and scale efficiency equals technical efficiency. Allocative efficiency measures the ability to choose cost minimizing input combinations or revenue-maximizing output combinations. Cost and revenue efficiency measure the firm's success in minimizing costs and maximizing revenues. Input-oriented distance functions are used to estimate cost efficiency and its components, and output-oriented distance functions are used for revenue efficiency. Using input-oriented cost efficiency and output-oriented revenue efficiency is the standard approach in economic applications of DEA, because the input-orientation implies a cost minimization model and the output-orientation implies a revenue maximization model, consistent with economic theory. The details of DEA estimation are presented in Cooper, Seiford, and Tone (2000).

4.3.2. Malmquist analysis for productivity

We use the Malmquist index approach to analyze changes in the total factor productivity of firms over time. The total factor productivity change of a firm has two primary components: the shift in the production frontier over time, representing technical change, and the shift in the firm's efficiency relative to the production frontier over time, representing efficiency change. There are several other ways to measure the productivity change of a firm (such as the Fisher index or the Törnqvist index), but the Malmquist index is adopted here because it permits the separation of technical change from efficiency change (Fare, Grosskopf, Norris and Zhang, 1994 (hereafter FGNZ 1994)) and is consistent with the DEA efficiency estimation methodology.[12]

To measure total factor productivity change, we utilize input-oriented Malmquist productivity indices. In decomposing the overall Malmquist index, it is important to adopt an assumption with respect to the returns to scale of the underlying technology, with the choices generally being constant returns to

[12] Generally, two types of Malmquist productivity indices are available – adjacent Malmquist indices and base period Malmquist indices (Althin, 2001). In this study, we adopt the adjacent Malmquist index. The adjacent-period approach measures productivity by comparing the frontiers in two adjacent years, whereas the base-period approach compares the frontiers in the two-years as they relate to a fixed base-period year. The adjacent Malmquist index is more appropriate for studying M&As because we are only concerned about the relative efficiency and technical change of M&A targets or acquirers before and after the M&As, and we do not worry about the target's technical change relative to a base period. A base period Malmquist index might be more applicable to static efficiency analysis because it obeys the circular relation (the chaining of the indices relative to the base period index). However, it has the drawback of base period technology dependency, which might be fatal if there is no similarity between the technologies in the two periods compared. Moreover, the selection of a base period is inevitably somewhat arbitrary.

scale (CRS) and variable returns to scale (VRS). As shown by Ray and Desli (1997), this assumption does not affect the overall Malmquist productivity index, which is correctly measured by the ratio of CRS distance functions even when the underlying technology exhibits VRS. However, the returns to scale benchmark does affect the decomposition of the index, which can be decomposed into indices representing pure efficiency change, technical change, and scale change. This decomposition is likely to provide useful information about the effects of M&As in the P-L insurance industry.

Because many firms in our sample are operating with increasing or decreasing returns to scale during the sample period, we utilize the VRS benchmark technology to perform the Malmquist index decomposition. The decomposition we use was originally developed by Ray and Desli (R-D) (1997). However, our decomposition differs from theirs in that we adopt an input-orientation rather than an output-orientation, consistent with our approach in the DEA analysis of firm efficiency. For purposes of comparison, we also decompose the Malmquist index using the CRS benchmark as in FGNZ (1994). We also note that Simar and Wilson (S-W) (1998) have criticized the scale change component of the R-D decomposition for confounding "the different effects of movement of production units in input/output space and changes in the shape of the technology over time" (S-W 1998, pp. 1-2). Accordingly, we also decompose R-D the scale change component into two more terms—scale efficiency change and scale technical change – using the S-W approach.

To elucidate the Malmquist methodology and decomposition, we consider **Figure 1**, which shows production frontiers for a single-input (X), single-output (Y) industry. The production frontier is formed by firms operating at points B, C, and D in period t and points B', C', D' in period t+1. The line $0V^{t}_{CRS}$ in Figure 1 represents the CRS frontier in period t, and the line $0V^{t+1}_{CRS}$ represents the CRS production frontier in period t+1. The line $EBCDV^{t}_{VRS}$ represents the VRS frontier in period t, while the line labeled $E'B'C'D'V^{t+1}_{VRS}$ represents the VRS production frontier in period t+1. Firm A produces at point A in period t and produces at point A' in period t+1. Obviously, this firm operates with VRS technology in both periods, i.e., it is not on the CRS production frontier, and it is also VRS inefficient. Two changes have occurred to this firm between time t and time t+1. First, the firm is using better technology in period t+1 to produce its output. In the figure, this firm's input-output combination in period t+1 would have been infeasible using period t technology. Second, the firm is operating closer to the frontier in period t+1 than in period t, indicating a technical efficiency gain between the two periods.

Our Malmquist analysis is based on input-oriented distance functions, given by:

$$D_r^t\left(x_i^s, y_i^s\right) = \sup\left\{\phi_i^s : \left(\frac{x_i^s}{\phi_i^s}, y_i^s\right) \in V_r^t\left(y_i^s\right)\right\} = \frac{1}{\inf\left\{\theta_i^s : \left(\theta_i^s x_i^s, y_i^s\right) \in V_r^t\left(y_i^s\right)\right\}} \tag{1}$$

where $D_r^t(x_i^s, y_i^s)$ = the input-oriented distance function for firm i in period s relative to the production frontier in period t with returns to scale technology r, where r = CRS for constant returns to scale and, r = VRS for variable returns to scale; and $\left(x_i^s, y_i^s\right)$ is the input-output vector for firm i in time period s. The production technology t, which transforms inputs into outputs, is modeled by an input correspondence $y^s \rightarrow V_r^t(y^s) \subseteq \mathbb{R}_+^k$. For any $y^s \in \mathbb{R}_+^n$, $V_r^t(y^s)$ denotes the subset of *all* input vectors $x^s \in \mathbb{R}_+^k$ which yield at least y^s, using a production technology with returns to scale r, where k and n are the dimensions of the input and output vectors, respectively. Notice that allowing the $s \neq t$ enables us to use distance function to estimate the productivity changes of firm i over time.

For example, let $D_{CRS}^t\left(D_{CRS}^{t+1}\right)$ represent the distance function relative to the CRS production frontier at time t (t+1), and $D_{VRS}^t\left(D_{VRS}^{t+1}\right)$ represent the distance function relative to the VRS production frontier at time t (t+1), where $\left(x_i^t, y_i^t\right)$ is input-output combination of firm i at time t, and $\left(x_i^{t+1}, y_i^{t+1}\right)$ is its input-output combination at time t+1. Then, from Figure 1, $D^{t}_{CRS}(x^{t}_{A}, y^{t}_{A}) = \frac{0a}{0c}$, $D^{t+1}_{CRS}(x^{t+1}_{A}, y^{t+1}_{A}) = \frac{0a'}{0e'}$, $D^{t}_{VRS}(x^{t}_{A}, y^{t}_{A}) = \frac{0a}{0b}$, and $D^{t+1}_{VRS}(x^{t+1}_{A}, y^{t+1}_{A}) = \frac{0a'}{0d'}$. Likewise, we can define $D^{t}_{CRS}(x^{t+1}_{A}, y^{t+1}_{A}) = \frac{0a'}{0c'}$, $D^{t+1}_{CRS}(x^{t}_{A}, y^{t}_{A}) = \frac{0a}{0e}$, $D^{t}_{VRS}(x^{t+1}_{A}, y^{t+1}_{A}) = \frac{0a'}{0b'}$ and $D^{t+1}_{VRS}(x^{t}_{A}, y^{t}_{A}) = \frac{0a}{0d}$. $D^{t}_{CRS}(x^{t}_{A}, y^{t}_{A})$ and $D^{t+1}_{CRS}(x^{t+1}_{A}, y^{t+1}_{A})$ compare the period t (t+1) input-output vector to the same period's production frontier, and must have value ≥ 1. However, if the frontiers shift over time, the distance function $D^{t}_{CRS}(x^{t+1}_{A}, y^{t+1}_{A})$ and $D^{t+1}_{CRS}(x^{t}_{A}, y^{t}_{A})$ can be <1, implying that a given period's input-output combination is infeasible using the other period's technology.

We first illustrate the FGNZ (1994) decomposition of productivity change, based on the CRS technology. A Malmquist index can be defined relative to either the technology in period t (written as M^{t}_{CRS}) or the technology in period t+1 (written as M^{t+1}_{CRS}),

$$M^{t}_{CRS} = \frac{D^{t}_{CRS}\left(x^{t}_{A}, y^{t}_{A}\right)}{D^{t}_{CRS}\left(x^{t+1}_{A}, y^{t+1}_{A}\right)}, \qquad \text{or,} \qquad M^{t+1}_{CRS} = \frac{D^{t+1}_{CRS}\left(x^{t}_{A}, y^{t}_{A}\right)}{D^{t+1}_{CRS}\left(x^{t+1}_{A}, y^{t+1}_{A}\right)} \tag{2}$$

where M^{t}_{CRS} measures productivity growth between periods t and t+1 using the period t reference technology, while M^{t+1}_{CRS} measures productivity growth between periods t and t+1 using the period t+1 reference technology. To avoid an arbitrary choice of technology, the Malmquist total factor productivity index is defined as the geometric mean of M^{t}_{CRS} and M^{t+1}_{CRS},

$$M_{CRS}\left(x^{t+1}_{A}, y^{t+1}_{A}, x^{t}_{A}, y^{t}_{A}\right) = \left[M^{t}_{CRS} * M^{t+1}_{CRS}\right]^{\frac{1}{2}} = [(0a/0c)(0c'/0a')(0a/0e)(0e'/0a')]^{\frac{1}{2}} \tag{3}$$

FGNZ (1994) decompose $M_{CRS}\left(x^{t+1}_{A}, y^{t+1}_{A}, x^{t}_{A}, x^{t}_{A}\right)$ into technical efficiency change (EFFCH) and technical change (TECHCH) as follows:

$$\text{EFFCH} = \frac{D^{t}_{CRS}\left(x^{t}_{A}, y^{t}_{A}\right)}{D^{t+1}_{CRS}\left(x^{t+1}_{A}, y^{t+1}_{A}\right)} \tag{4}$$

$$\text{TECHCH} = \left[\left(\frac{D^{t+1}_{CRS}\left(x^{t+1}_{A}, y^{t+1}_{A}\right)}{D^{t}_{CRS}\left(x^{t+1}_{A}, y^{t+1}_{A}\right)}\right)\left(\frac{D^{t+1}_{CRS}\left(x^{t}_{A}, y^{t}_{A}\right)}{D^{t}_{CRS}\left(x^{t}_{A}, y^{t}_{A}\right)}\right)\right]^{\frac{1}{2}} \tag{5}$$

A Malmqusit index >1 (<1) implies total factor productivity growth (decline), and similar interpretation for technical efficiency change and technical change.

The Ray-Desli (1997) decomposition of the Malmquist index utilizes VRS as the benchmark technology, allowing for the possibility that some firms have not achieved CRS. Accordingly, we decompose the input-oriented Malmquist index into pure efficiency change (PEFFCH), pure technical change (PTECHCH), and scale change (SCH), where $M_{CRS}\left(x^{t+1}_{A}, y^{t+1}_{A}, x^{t}_{A}, y^{t}_{A}\right)$ = PEFFCH* PTECHCH* SCH. The components are defined as follows:

$$\text{PEFFCH} = \frac{D^{t}_{VRS}\left(x^{t}_{A}, y^{t}_{A}\right)}{D^{t+1}_{VRS}\left(x^{t+1}_{A}, y^{t+1}_{A}\right)} \tag{6}$$

$$\text{PTECHCH}=\left[\left(\frac{D_{VRS}^{t+1}\left(x_A^{t+1},y_A^{t+1}\right)}{D_{VRS}^{t}\left(x_A^{t+1},y_A^{t+1}\right)}\right)\left(\frac{D_{VRS}^{t+1}\left(x_A^{t},y_A^{t}\right)}{D_{VRS}^{t}\left(x_A^{t},y_A^{t}\right)}\right)\right]^{\frac{1}{2}} \quad (7)$$

$$\text{SCH}=\left[\frac{D_{CRS}^{t}\left(x_A^{t},y_A^{t}\right)}{D_{VRS}^{t}\left(x_A^{t},y_A^{t}\right)}\frac{D_{VRS}^{t+1}\left(x_A^{t+1},y_A^{t+1}\right)}{D_{CRS}^{t+1}\left(x_A^{t+1},y_A^{t+1}\right)}\frac{D_{CRS}^{t+1}\left(x_A^{t},y_A^{t}\right)}{D_{VRS}^{t+1}\left(x_A^{t},y_A^{t}\right)}\frac{D_{VRS}^{t}\left(x_A^{t+1},y_A^{t+1}\right)}{D_{CRS}^{t}\left(x_A^{t+1},y_A^{t+1}\right)}\right]^{\frac{1}{2}} \quad (8)$$

The pure efficiency change component (PEFFCH) compares the firm's distance from the VRS frontier in period t to its distance from the VRS frontier in period t+1. If the firm has moved closer to the frontier in period t+1, this ratio will be > 1. In Figure 1, PEFFCH = [(0a/0b)/(0a'/0d')]. The pure technical change component (PTECHCH) measures the shift in the VRS frontier between periods t and t+1 with respect to the operating points of firm A in the two periods. If the operating point in period t is further from the frontier in period t+1 than in period t, the implication is that the frontier has shifted to the left, implying that technology has improved, and likewise for the period t+1 operating point. In Figure 1, $\text{PTECHCH} = \{[(0a'/0d')/(0a'/0b')][(0a/0d)/(0a/0b)]\}^{\frac{1}{2}}$.

The scale change component (SCH) of the input-oriented Malmquist index is somewhat complicated and lacks intuition. As a result, Simar and Wilson (1998) design a further decomposition for this term into scale efficiency change (SEFFCH) and scale technical change (STECHCH), where SCH= SEFFCH* STECHCH. The components are given by:

$$\text{SEFFCH}=\frac{D_{CRS}^{t}\left(x_A^{t},y_A^{t}\right)\big/D_{VRS}^{t}\left(x_A^{t},y_A^{t}\right)}{D_{CRS}^{t+1}\left(x_A^{t+1},y_A^{t+1}\right)\big/D_{VRS}^{t+1}\left(x_A^{t+1},y_A^{t+1}\right)} \quad (9)$$

$$\text{STECHCH}=\left\{\left[\frac{D_{CRS}^{t+1}\left(x_A^{t},y_A^{t}\right)\big/D_{VRS}^{t+1}\left(x_A^{t},y_A^{t}\right)}{D_{CRS}^{t}\left(x_A^{t},y_A^{t}\right)\big/D_{VRS}^{t}\left(x_A^{t},y_A^{t}\right)}\right]\left[\frac{D_{CRS}^{t+1}\left(x_A^{t+1},y_A^{t+1}\right)\big/D_{VRS}^{t+1}\left(x_A^{t+1},y_A^{t+1}\right)}{D_{CRS}^{t}\left(x_A^{t+1},y_A^{t+1}\right)\big/D_{VRS}^{t}\left(x_A^{t+1},y_A^{t+1}\right)}\right]\right\}^{\frac{1}{2}} \quad (10)$$

The scale efficiency change component (SEFFCH) compares the firm's scale efficiency in period t+1 to its scale efficiency in period t. If the firm has become more scale efficient in period t+1, SEFFCH will be > 1. It measures changes in the scale efficiency of the firm due to changes in the location of this firm in input/output space between time t and t+1 and/or the changes in the shape of the technology between the two periods. In Figure 1, SEFFCH = [(0b/0c)/(0d'/0e')].

The scale technical change (STECHCH), as interpreted by Simar and Wilson (1998), describes the change in the scale of technology at two fixed points (defined by the firm's operating points at times t and t+1). The first ratio in STECHCH measures the change in the scale, or shape, of the technology between time t and t+1, relative to the firm's operating points at time t, while the second ratio in STECHCH measures the change in the scale, or shape, of the technology between time t and t+1, relative to the firm's operating points at time t+1. In Figure 1, STECHCH = $\left[\left(\frac{0a/0e}{0a/0d}\Big/\frac{0a/0c}{0a/0b}\right)\left(\frac{0a'/0e'}{0a'/0d'}\Big/\frac{0a'/0c'}{0a'/0b'}\right)\right]^{\frac{1}{2}}$.

[See Figure 1]

4.3.3. Estimation window

We analyze the effect of M&As by estimating the efficiency and productivity change of the firms in our sample between the period prior to and the period after the acquisition for acquirers and targets and for the same window for non-M&A firms. We estimate the change in three windows: (1) One year prior to acquisition (t-1) to one year after acquisition (t+1); (2) two years prior to acquisition (t-2) to two years after acquisition (t+2); and (3) one year prior to acquisition (t-1) to two years after acquisition (t+2) to see the short-term effects and relatively long-term effects of M&As. For example, for the (t-1) to (t+2) window, we compute distance functions relative to the frontiers in (t-1) and (t+2). The results for the different estimation windows are very similar, and we only report the results from the (t-1) to (t+2) window, because it provides more time to measure the effects of post-merger integration but has a larger sample size than the window beginning at (t-2).

5. Estimation results: Efficiency and productivity change

5.1. Summary statistics

This section presents the summary statistics on the financial and operating characteristics of the firms in our sample.[13] The summary statistics on acquirers and non-acquirers, presented in **Table 1**, show some statistical differences between the two types of firms.[14] The acquiring firms are on average much larger than non-acquiring firms, with mean assets of $6.0 billion versus $727 million for non-acquirers. Reflecting their larger size, only 12.6% of acquirers operate with non-decreasing returns to scale compared to 57.4% for non-acquirers. Only 20.7% of acquirers are mutuals, compared to 39.0% for non-acquirers; and only 2.1% of acquirers are unaffiliated firms, compared to 57% for non-acquirers. On average, acquiring firms are more diversified over geographical areas and business lines than non-acquiring firms, as measured by Herfindahl indices based on premium volume by state and line of business, respectively.

Reflecting their size and better diversification, the acquiring firms have significantly lower capital-to-asset ratios than non-acquirers, are significantly more likely to have an A+ financial rating, and are significantly less likely to have financial ratings below A-. Acquiring firms also have significantly higher returns on equity than non-acquirers. Acquirers have significantly higher loss ratios but lower expense ratios than non-acquirers, and the average combined ratios (loss ratio plus expense ratio) are equal for the two groups of firms. Acquiring firms have higher reserve leverage (loss reserves/surplus) but lower underwriting leverage (premium/surplus) than non-acquirers. The higher reserve leverage is attributable primarily to business mix – acquirers have significantly more of their premiums from commercial long-tail lines and less from commercial short-tail lines than do the non-acquirers.

Acquiring companies are more cost efficient than non-acquiring firms because they have higher allocative and pure technical efficiencies than non-acquirers, offsetting their lower scale efficiencies. Acquiring firms are less revenue efficient on average than non-acquirers. These results may suggest that acquirers undertake M&As to improve their own revenue efficiency by broadening their product offerings or entering new markets. The Malmquist indices show that acquiring companies exhibit no change in total factor productivity (index = 1), whereas non-acquirers show slight improvements in total factor productivity on average (index = 1.05).

[See Table 1]

The summary statistics on targets and non-targets is presented in **Table 2**. [15] There is no significant size difference between targets and non-targets in terms of average assets or premiums. The averages provide some evidence that targets do not perform as well financially as non-targets. Targets have significantly lower capital-to-assets ratios and liquidity ratios than non-targets, and they also have significantly higher reserve and premium leverage than non-targets. Moreover, targets have higher

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[13] We also do a proportion test to see whether the proportion of targets or acquirers that experience improvement in TFP, CE, AE, RE etc. is different from that of non-targets or non-acquirers. The result confirms the mean tests.

[14] The non-acquiring firms only include firms that do not engage in any M&A transactions in a certain year.

[15] The non-targets category only includes firms that do not engage in any M&A transactions in a certain year, which means that it has excluded the member companies of valid acquirers, member companies of sellers, and member companies of invalid acquirers (firms that acquire but do not pass the sample selection criteria for being valid acquirers in this study).

combined ratios and are significantly less likely to be rated A+ than non-targets.

A lower percentage of targets operate with non-decreasing returns to scale than non-targets (41.1% versus 59.0%). Recalling that most acquiring companies operate with decreasing returns to scale, this result suggests that scale economies are not a predominant reason for M&As during our sample period. Consistent with the hypotheses that unaffiliated companies are less likely to be takeover targets, only 13.3% of targets are unaffiliated single companies compared to 32.9% of non-targets. About 5% of targets are mutual companies, compared to 25.5% of non-targets, confirming that mutuals are less likely to be M&A targets than stocks.

Targets firms have higher cost, technical, pure technical and scale efficiency than non-targets, and significantly higher revenue efficiency than non-targets, suggesting that acquirers tend to target relatively efficient firms in M&A transactions. There is no significant difference in total factor productivity change on average between targets and non-targets. However, targets have lower technical efficiency change and higher technical change than non-targets, perhaps suggesting that targets have the opportunity to produce with a more advanced technology than non-targets after being acquired, while the lower technical efficiency change suggesting that the targets have not fully realized all the potential of new technology. The R-D and S-M decomposition demonstrates that targets experience slower pure technical efficiency improvement and more scale technology retrogression than non-targets, but they manage to achieve better pure technical change. Allocative efficiency gains are significantly larger for targets than for non-targets, suggesting that acquirers may succeed in improving the efficiency of target firms. However, there are no significant differences in efficiency changes overall between targets and non-targets for either cost or revenue efficiency.

[See Table 2]

5.2. Regression analysis of productivity and efficiency change

In this section we present multivariate regression models with productivity and efficiency changes as dependent variables and firm characteristics as independent variables. There are two sets of regressions – one based on the group and unaffiliated sample efficiency and productivity estimates (Table 3), and the other based on the company sample efficiency and productivity estimates (Table 4). The regressions based on the group and unaffiliated sample estimates utilize the acquirer and non-acquirer sample from Table 1, and the company sample regressions use the target and non-target sample from Table 2.

Regressions for ten different dependent variables are shown in Tables 3 and 4. Seven dependent variables come from the Malmquist index analysis, specifically, total factor productivity change, the CRS decomposition into technical efficiency change and technical change, and the VRS (R-D and S-W) decomposition into pure technical efficiency change, pure technical change, scale technical change, and scale efficiency change. We also conduct regressions where the dependent variable measure changes in efficiency, specifically, cost, allocative, and revenue efficiency, respectively. These efficiency changes are similar to the efficiency change components in the Malmquist indices, i.e., they measure whether a firm has moved closer to or further away from the frontiers over the two periods of comparison. More precisely, the efficiency change variables for year t are defined as the ratio of a firm's efficiency in year (t+2) to its efficiency in year (t-1). Because the dependent variables are over the (t-1) to (t+2) window, the regressions cover the M&A transactions occurring 1994 through 2001. The regressions are estimated using ordinary least squares.[16]

Independent variables are included in the regressions to control for firm characteristics that may be systematically related to productivity and efficiency change. The log of assets is included to control for firm size. A dummy variable equal to 1 for mutual firms and zero for stock insurers is included to control for organizational form, and a dummy variable equal to 1 for unaffiliated companies and equal to zero for groups is included to control for differences due to corporate structure. To control for business mix, we

[16] Robust least square regression gives the same result.

utilize dummy variables equal to the proportion of a firm's premiums in personal short-tail lines (PST), personal long-tail lines (PLT), and commercial long-tail lines (CLT), with commercial short-tail lines (CST) as the omitted category. To control for the effects of diversification, we include in the regression models the firm's geographical Herfindahl index based on the proportion of net premiums written by state and its product line Herfindahl index based on the proportion of net premiums written by product lines. Herfindahl indices are inversely related to diversification. The premium/surplus ratio is included in the regression to control for the effects of underwriting leverage. The values of the independent variables are lagged by one year for all firms and thus represent the year prior to acquisition for acquirers and targets. Acquisition year dummies are also included in the model to control for time effects, with 1994 as the omitted year.[17]

The regressions for the sample of groups and unaffiliated single companies are shown in **Table 3**. A dummy variable equal to 1 for acquirers and zero for non-acquirers is used to test for differences between these two categories of firms. The regressions, shown in Table 3, reveal no significant difference in total factor productivity between acquirers and non-acquirers. However, acquirers experience lower pure technical change and higher scale technical change than non-acquirers. Cost and allocative efficiency change do not differ significantly between acquirers and non-acquirers. However, acquirers experience higher revenue efficiency gains than non-acquirers over the (t-1) to (t+2) window. Thus, M&As may have enabled acquirers to improve their scope economies or otherwise recognize improvements in revenue efficiency.

The negative coefficient on the log of assets implies that larger firms experience significantly lower total factor productivity change than smaller firms, and larger firms also experience significant reductions in cost and revenue efficiency change over the (t-1) to (t+2) window. The R-D, S-W decomposition shows that large firms achieve higher pure technical change than smaller firms but that these gains are offset by productivity losses due to reduction in pure technical efficiency change, scale technical change, and scale efficiency change. Mutual insurers achieve lower total factor productivity and lower changes in cost and revenue efficiency than stock firms, as expected if mutuals have less incentive to minimize costs and maximize revenues and/or if mutual managers exhibit expense preference behavior. This result also might be consistent with the hypothesis that mutual firms tend to specialize in lines of insurance that are not too complex or risky and thus provide less opportunities for efficiency improvement.

Firms that are more geographically diversified achieve higher total factor productivity gains than less diversified firms, primarily due to pure technical efficiency change and scale technical change. More geographically diversified firms also achieve higher revenue efficiency growth than less diversified firms. Firms that are more diversified by line also realize significantly larger total factor productivity growth than less diversified firms and also show significantly higher growth in cost and revenue efficiency. These results are consistent with diversified firms benefiting from economies of scope, leading to revenue efficiency gains, and also possibly consistent with such firms having lower capital costs due to earnings diversification, leading to cost efficiency gains. We also find that unaffiliated companies gain less in total factor productivity than groups due to their smaller growth in pure technical efficiency. This might be because unaffiliated firms tend to specialize in certain businesses for a long time, providing little room for improvements in efficiency. They also improve less in cost and allocative efficiency.

Firms with a higher proportion of business in personal short-tail (PST), personal long-tail (PLT) lines, and commercial long-tail (CLT) lines all show greater revenue efficiency gains than those with more business in commercial short-tail (CST) lines, and cost efficiency gains are significantly greater for firms with more concentration in PST and CLT lines. In terms of total factor productivity change, only those firms with relatively high concentrations in PLT lines are significantly different from those firms with more business in CST lines. The greater TFP gains are attributable to pure technical efficiency change and scale change in the R-D, S-W decomposition and to technical change in the FGNZ decomposition. This might be because PLT business, primarily personal auto liability, has been relatively

[17] The data are arranged such that 1994 corresponds to the 1993 data for all the year-1994 firms in the sample.

advanced in terms of adopting new marketing, customer service, and claims settlement technologies, giving rise to more opportunities for productivity gains.

The regression results in Table 3 also show that firms with higher premiums-to-surplus ratios have lower total factor productivity growth and lower cost and revenue efficiency growth. This might be because firms with a high underwriting leverage, holding other factors equal, are more efficient in their output scale, and there is less room for them to improve; or it could indicate the constraints created by debt overhang in highly leveraged firms.

[See Table 3]

The regression analysis based on the affiliated and unaffiliated company sample, presented in **Table 4**, is used to test for productivity and efficiency improvements of target companies. This sample includes M&A targets as well as affiliated companies whose groups were not involved in M&As and unaffiliated companies not involved in M&As. The target dummy variable in the regressions shows that target firms achieve similar productivity growth as non-targets. Thus, the target firms do not become more productive following acquisition in comparison with non-target firms. Targets also are not statistically different from non-targets in terms of revenue efficiency change. However, targets do show significantly higher allocative and cost efficiency growth than non-targets, indicating that M&As are efficiency-improving along this dimension, i.e., targets apparently achieve better resource allocation following acquisition, leading to cost efficiency gains. Combining these findings with our summary statistics and regression analysis for acquirers companies, we can conclude that both financial synergy and operating synergy may have played an important role during this M&A wave. The acquirers tend to improve their revenue efficiency through M&As, while at the same time enhancing the allocative and cost efficiencies of the targets.

Most control variables in the Table 4 regression have signs and significances similar to those in Table 3. One important exception is the product line Herfindahl index, which is generally negative in Table 3, but is positive and significant in the Table 4 regressions for total factor productivity change, cost efficiency change, and revenue efficiency change and also for some of the productivity and efficiency decomposition regressions. This suggests that more focused companies tend to show higher overall productivity and efficiency growth than less focused companies. This is consistent with the general operating model in the insurance industry, where groups tend to diversify by conducting specialized operations through separate subsidiaries rather than through departments or divisions, explaining why higher productivity and efficiency gains accrue to diversified groups and focusing companies. However, geographical diversification is still generally beneficial at the company level, supporting the interpretation that it is line of business specialization that is valuable for companies.

[See Table 4]

6. Estimation results: Likelihood of takeover

In this section we conduct a probit analysis to determine firm characteristics associated with firms' becoming acquirers and targets. To objective is to help reveal the motivations underlying the consolidation wave in the P-L insurance industry during our sample period. The independent variables in the probit model representing firm characteristics that are lagged one year, i.e., represent year t-1, whereas the dependent variables (0-1 variables for acquirers and targets) represent year t, which is the acquisition year for acquirers and targets. Estimation is conducted using maximum likelihood probit analysis.

To test the hypothesis on scale economies, we include a dummy variable equal to 1 for NDRS firms and 0 for DRS firms. If the scale economy hypothesis holds, the coefficient of this variable should be positive for both the target probit and acquirer probit models. The variables that measure the pre-acquisition performance of a firm include efficiency scores, the loss ratio, the underwriting expense ratio, and pre-tax return on equity (ROE).[18] Since acquisitions require resources, we expect that firms with higher ROE are more likely to become acquirers. In addition, a higher pre-tax ROE means that M&As have potential tax benefits for the acquirers. For the acquirer regressions, we do not have a clear sign prediction for efficiency variables and the loss ratio or expense ratio, since acquiring companies do not have to outperform their peers to become acquirers. For the target probit regressions, if corporate control theory holds we should find negative signs on the efficiency variables and positive signs on the loss and expense ratio variables, indicating that poorly performing firms are likely to become targets because of the potential for efficiency gains by replacing incumbent management. On the other hand, if efficient firms are more attractive to acquirers because acquirers are seeking to enter new lines of businesses or geographical areas or to acquire technologies, then we should find one or more positive signs on the efficiency variables for the target probit model. Because efficiencies tend to be correlated with each other, we include only one type of efficiency in each regression.

The capital-to-asset ratio is included in the model to proxy for the financial strength of a firm.[19] We expect a positive sign on the capital-to-asset ratio in the acquirer probit regressions if better capitalized firms are more likely to become acquirers. We do not have a strong prediction for this variable in the target firm regressions. If it is efficient for acquirers to seek financially vulnerable firms that have other desirable operating characteristics, this variable may have a negative relationship with the probability that a firm becomes a target. However, if financial vulnerability is viewed as a liability in the M&A market, then the variable may be positive.

The geographical and product line Herfindahl indices are used to proxy for diversification. We do not have a strong prediction on these Herfindahls. If it makes sense for firms seeking new markets or core competencies to acquire firms that specialize in certain regions or certain products in order to acquire their expertise in these markets, then the Herfindahl variables may have positive signs in the target firm regressions. On the other hand, if acquirers value diversification in selecting targets, these variables may have negative signs. It is also possible that firms that seek earnings diversification will find it cost effective to acquire firms that are more diversified in geographical areas or product lines but not both.

The variable used to proxy for asset portfolio risk is the proportion of invested assets in stocks. We expect a positive effect of investment in stocks in the target probit because the higher the percentage of a firm's investment in stocks, the higher the risk a firm will face due to stock volatility, and the higher its chance of encountering financial distress. The effect of stock investment could be the same for the acquirers; however, a positive sign is also possible for acquirers if existing stock investment in target companies helps to smooth the acquisition process.

The variables measuring other characteristics of a firm include size, measured by the log of assets, a mutual dummy for organizational form, an unaffiliated dummy for corporate structure, the growth rate (percent change in premiums), and business mix. For size, we expect a positive sign in the acquiring probit and a negative sign in the target probit, because large companies have an advantage in being an acquirer and small companies are easier to acquire than large ones. The sign for the mutual dummy should be negative in both the acquiring and target probits to be consistent with the hypotheses that mutuals are less likely to be acquirers because of their more limited access to capital and that mutual targets are more difficult to acquire. The sign on the unaffiliated firm dummy is predicted to be negative in the target firm probit regressions, consistent with the hypothesis that the managers of unaffiliated companies are more likely to resist takeover offers to protect their job security. This variable also may be negative in the acquirer probit regressions if the lack of a group structure inhibits acquisitions.

The predicted sign of the growth rate variable in both the acquirer and target probits is ambiguous. Acquirers with high growth rates may have more resources to use in acquisitions but also are less in need of acquisitions to increase firm size. Targets with high growth rates are likely to be more expensive to acquire, but high growth also makes such firms more attractive. We expect a positive sign on takeover year dummies in the target probit after 1994, because of the effect of the Northridge earthquake and RBC

[18] Pre-tax return on equity is defined as Net income after policyholder dividend but before tax/Policyholder surplus.
[19] Liquidity is not included, since it is highly correlated with the capital/asset ratio.

regulation on the industry as well as booming equity markets, and a negative sign since 2001 because of the sluggish stock market and the depleted capital capacity of the U.S. P-L industry following 2001 terrorist attacks.

The probit regressions for the probability that a firm becomes an acquiring company are presented in **Table 5**. The regressions are based on the group and unaffiliated firm sample. The dependent variable is 1 if a firm is an acquiring company and 0 if it is a non-acquiring company. The probit regression for target firms are shown in Table 6, based on the affiliated and unaffiliated company sample. The dependent variable in the Table 6 regressions is 1 if a firm is an M&A target and 0 otherwise.

The NDRS dummy variable is not significant in the acquirer probit, and is significantly negative in the target probit, suggesting that scale economies were not a major consideration during the P-L insurance merger wave.

The efficiency variables in the acquirer probit regressions (Table 5) are mostly insignificant. However, the coefficient of pure technical efficiency is significant and negative, suggesting that technologically advanced firms may have less need to make acquisitions to improve their technologies. The Table 5 regressions confirm that large firms are more likely to be acquirers, based on log of assets coefficients, which are positive and highly significant. The pre-tax ROE variable is also positive and significant, as expected if more profitable firms have more resources to engage in M&As and/or have stronger tax incentives to make acquisitions.

As predicted, the coefficients on the unaffiliated firm dummy variable are negative and significant, implying that groups are more likely to be acquirers than unaffiliated firms. The only business mix variable that is significant in the acquirer regressions is the proportion of business in commercial long-tail lines. This variable has a positive coefficient, perhaps suggesting that firms with more exposure in the relatively risky commercial long-tail lines have more motivation to engage in M&As to increase their diversification. This finding is consistent with the observation that long-tail commercial business market is highly competitive, inducing more M&As to improve operating efficiency (Graham and Xie, 2005). The capital-to-asset ratio and the Herfindahl index variables are insignificant in the acquirer regressions. Likewise, the mutual dummy variable is negative as expected but insignificant, providing only weak support for the hypothesis that mutuals are less likely to be acquirers. This is consistent with the observation that large mutuals have a dominant presence in the P-L market, especially in the personal lines.

[See Table 5]

The target probit regressions in **Table 6** provide support for the hypothesis that poorly performing firms are more likely to be takeover targets. The cost efficiency variable has a significant negative coefficient in the probit regression, suggesting that cost-inefficient firms are more attractive M&A targets than cost efficient firms. The coefficients of the loss ratio and expense ratio are positive and significant, implying that firms with relatively poor underwriting experience are more likely to be acquired. The capital-to-asset ratio is negative and significant, implying that firms with low capitalization are more likely to become acquisition targets. These results, combined with the target regressions in Table 4, provide some support for the corporate control theory that poorly performing firms are more likely to be targets and that their efficiency is improved after acquisition. Possibly contrary to this conclusion are the significant positive coefficients on the pre-tax ROE variable in four of the five Table 6 regressions, implying that firms with high ROE are *more* likely to be acquired. However, this result may suggest that otherwise poorly performing firms that are relatively profitable make attractive takeover targets.

The geographical Herfindahl is negative and significant in the target probit regressions, implying that geographically diversified firms are more attractive to buyers because they provide business opportunities for buyers in new regions or are valuable to achieve earnings diversification. The product line Herfindahl is significant and positive in three of the five target probit regressions. This suggests that focused firms are more attractive as takeover targets, perhaps because of their specialized knowledge of specific markets or because it is easier or less costly for an acquirer to integrate a specialized firm than a diversified one. The percentage of investment in stocks is not significant in the target probit, perhaps because investment portfolios can be restructured quickly and easily if they do not fit in with the acquirer's strategy.

As expected, mutual companies are significantly less likely to be takeover targets. The unaffiliated firm dummy is negative as expected but insignificant, providing only weak support for the hypothesis that unaffiliated firms are more likely to resist takeover attempts. Firms with high proportions of their business in commercial short-tail lines are least likely to be M&A targets, and the personal lines short-tail variable has the highest coefficient among the business mix variables included in the equation. This would be consistent with personal lines short-tail firms being merged into larger entities to achieve better diversification due to the catastrophic risk exposure of personal lines short-tail coverages.

The year dummy variables are positive and significant for acquirers in 1998 and 2000 and are positive and close to significant for 1999, and these variables are positive and significant for targets in 1998-2000, identifying these three years as a "hot" period for P-L M&As. This is likely attributable to the booming stock market and low leverage levels during this period, which made more funds available for acquisitions. The "soft" insurance market during this period also led to reduced underwriting profits, leading to the acquisition of some financially vulnerable firms. Reflecting declining equity markets and the underwriting losses from the September 11, 2001 terrorist attacks, the year dummy variables are negative for 2002 for acquirers and negative for 2001-2002 for targets, although these variables are not statistically significant. Thus, there is some evidence for the industry shock theory of M&As during our sample period.

[See Table 6]

7. Conclusion

This paper examines the motivation and productivity and efficiency effects of the M&As in the U.S. P-L insurance industry during the period 1994-2003. We use data envelopment analysis (DEA) to estimate efficiency and Malmquist indices to measure the productivity change of firms. The Malmquist indices are decomposed using both constant and variable returns to scale technologies. Regression analysis with productivity and efficiency change as dependent variables is used to analyze firm characteristics associated with performance gains, and we also study the probability that firms become involved in M&A activity as acquirers or targets.

The analysis provides information relating to two primary hypotheses about the effects of M&As on target and acquiring firms – (1) the value maximization or synergy hypothesis and (2) the hypothesis that M&As are primarily driven by non-value maximizing behavior by managers. Value maximizing motivations include achieving economies of scale and scope, improving X-efficiency, gaining market power, achieving earnings diversification and improvements in other aspects of financial performance. Motivations that are consistent with the non-value maximizing behavior by the management of acquiring firms include various agency theory explanations such as managerial hubris, empire-building, increasing managerial compensation, and expense preference behavior. If synergies primarily motivate M&As, we expect to observe improvements in productivity and efficiency in acquirers and/or targets following acquisitions and also expect firm financial characteristics to relate to the probabilities of becoming acquirers or targets in ways that are consistent with value-maximization M&A theory. If non-value-maximizing motives predominate, we expect productivity or efficiency losses as a result of M&As and other findings inconsistent with value-maximization theories.

The results of the analysis are generally consistent with value-maximizing motives being dominant in the P-L insurance M&A market. The regression analysis provides strong evidence that acquiring firms achieve more revenue efficiency growth than non-acquirers and that target firms experience greater cost and allocative efficiency growth than non-targets. Combined with the evidence that target are more revenue efficient than non-targets, and acquirers are more cost and allocatively efficient but less revenue efficient than non-acquirers before M&A transactions, this suggests that operating synergy exists between acquirers and targets in the U.S. P-L industry, and the restructuring of the industry in the 1990s and early 2000s has produced efficiency gains.

Probit models are used to estimate the probability of being a takeover target or acquirer. We find strong evidence that financially vulnerable firms are more likely to become M&A targets, consistent with corporate control theory, which predicted that poorly performing firms will be acquired by firms seeking to improve their performance. Firms that are relatively cost inefficient, have poor underwriting performance as measured by the loss and expense ratio, and low capital-to-asset ratios are more likely to become acquisition targets. The clustering of M&As in the years 1997-2000 also provides some evidence for the industry shock theory and suggests that catastrophic shocks, the resulting alterations of hard and soft market, regulation, as well as the booming stock market, played a role in the M&A wave during the sample period.

During our sample period, firms that are more concentrated in business mix and more diversified geographically are more likely to become takeover targets, indicating a preference among acquirers for targets that are product focused but geographically diversified. The geographical diversification result is consistent with earnings diversification as a primary motive for M&As. Having non-decreasing returns to scale is unrelated to being an acquirer but is inversely related to the probability of becoming a target, suggestion that scale economies were not a predominant motive for M&As during the sample period. As anticipated, large companies are more likely to be acquirers, unaffiliated single insurers are less likely to engage in takeovers, particularly as acquirers, while mutuals are less likely to be takeover targets. In general, we conclude that M&As in the U.S. P-L insurance industry during the 1990s and early 2000s produce both financial and operating synergies for acquirers and targets and help to improve cost and revenue efficiency, while meanwhile maintaining the total factor productivity of firms.

Appendix: Smoothing of Outputs and Output Prices

We smoothed the output series to correct for the potential "errors in variables" problem. The procedure is as follows: First, in each year and for each output, we rank companies by their premium market share. Companies whose market shares place them in the top 95% of the market are considered competitive companies. Other companies, i.e., the ones that split the remaining 5% of the market, are considered small companies. We then calculate the price ratio for each output (i) in each year (t) for each company (j): $PR_{ijt} = \frac{P_{ijt}}{PV(L_{ijt})}$ where PR_{ijt} = output price for output i, company j, in year t, P_{ijt} = premiums earned, L_{ijt} = losses incurred, and PV(•) = the present value operator.[20] We next determine the 10th, 25th, 75th, and 90th percentiles of the price ratio for each output and year based on the competitive companies.

For small companies, if their $PR_{ijt}s$ fall between the 25th and 75th percentile of the competitive company $PR_{ijt}s$, we use their actual $PR_{ijt}s$ to represent output price. If their $PR_{ijt}s$ fall below the 25th percentile and above the 75th percentile of the competitive company prices, we set the small company price equal to the 25th percentile or 75th percentile, respectively, of the competitive company prices. For a competitive company, if its PR_{ijt} is below 10th percentile or above 90th percentile of the competitive company prices, we set its price equal to the 10th percentile or 90th percentile, respectively, of the competitive company price distribution.

Second, for each firm in the sample, we fit a linear time trend to the new series of price ratios PR_{ijt} obtained from the first step and then calculate a smoothed price ratio series. The linear trend regression for each firm j and output i is:

$$PR_{ijt} = \alpha_{ij} + \beta_{ij} t + \varepsilon_{ij}$$

where PR_{ijt} = the price for line i, company j, in year t; i=1, 2, 3, 4, indicate personal lines short-tail, personal lines long-tail, commercial lines long-tail and commercial lines short-tail output, respectively; and t=1, 2, …11, corresponds to the years 1993-2003.

The smoothed price ratio for output i, firm j, and year t is then calculated as:

$$\hat{PR}_{ijt} = \hat{\alpha}_{ij} + \hat{\beta}_{ij} t \quad \text{, for t=1, 2 … 11.}$$

Third, we divide firm j's actual premiums earned by the new smoothed price ratio $\hat{PR}_{ijt}$ and get the estimated smoothed losses of the company, which measures output quantity for line i, i.e.,

$$\hat{L}_{ijt} = \frac{P_{ijt}}{\hat{PR}_{ijt}}, \quad \text{where } \hat{L}_{ijt} \text{ = smoothed losses incurred for line i, company j, and year t.}$$

[20] Note that 1 is subtracted from the price ratio in measuring price for purposes of efficiency estimation.

Figure 1
Efficiency and Productivity Measurement
Single Input-Single Output Firm

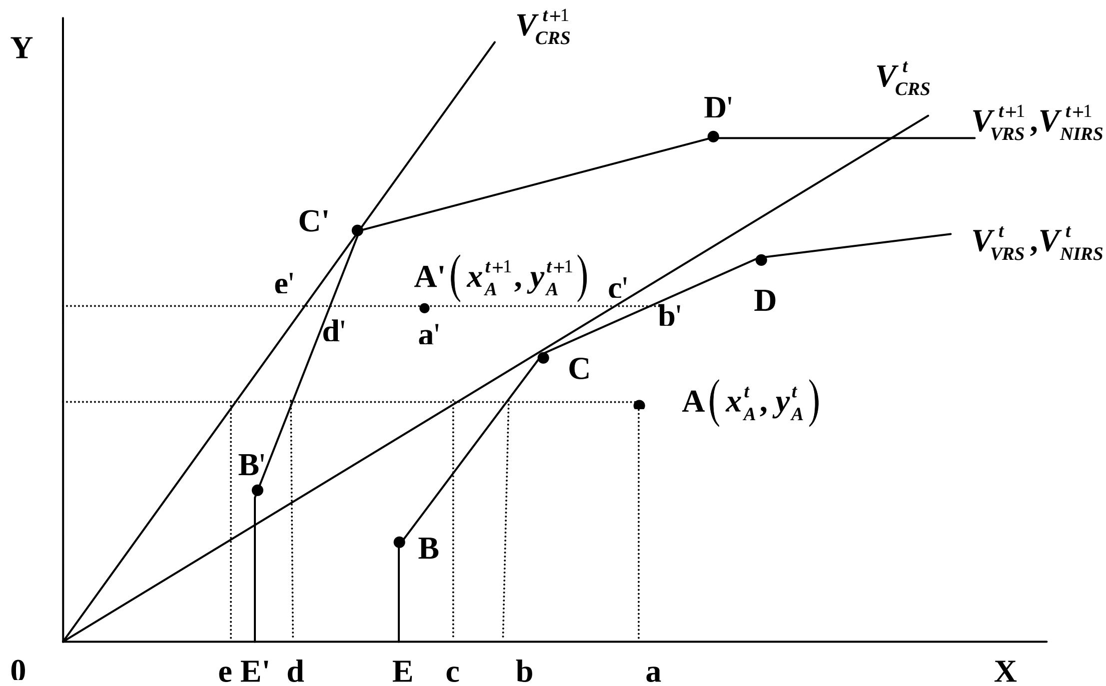

Table 1
Summary Statistics for Acquirers and Non-acquirers[1], 1994-2003

Variable	Non-acquiring firms		Acquiring firms	
	Mean	Std. dev	Mean	Std. dev
Company Characteristics				
Observations	7633		146	
Total assets ($ million)	727.10	3,024.02	6,040.82	9660.47***
Capital / total assets	0.45	0.19	0.39	0.14***
Liquidity ratio	1.67	0.72	1.41	0.47***
Operating cash flow / total assets	0.08	0.07	0.05	0.04***
Premium / Surplus	1.18	0.79	0.99	0.51***
Loss & LAE reserves / surplus	0.92	0.85	1.17	0.71***
Return on asset	0.05	0.05	0.05	0.05
Return on equity (net income after tax/policyholder surplus)	0.10	0.08	0.11	0.08**
Net income before tax / premium earned	0.22	0.40	0.20	0.25
Loss & LAE incurred / premiums earned	0.69	0.24	0.74	0.17**
Underwriting expense / premiums written	0.39	0.30	0.34	0.3**
Invested income / premium earned	0.20	0.41	0.18	0.20
Invested assets / total assets	0.88	0.09	0.86	0.08*
Percent of invested assets in real estate	3.7%	4.1%	1.5%	1.5%***
Percent of invested assets in stocks	18.8%	15.9%	24.6%	15.3%***
Percent of invested assets in bonds	66.0%	21.4%	64.3%	17.2%
Percent of invested assets in mortgages	2.0%	4.0%	1.1%	2.9%*
Total Premiums ($ millions)	226.06	841.39	1,567.33	2486.34***
Percent change in premiums, t-2 to t-1	1.15	0.62	1.16	0.38
Percent of premiums in personal lines short-tail	9.2%	14.9%	11.2%	11.0%
Percent of premiums in personal lines long-tail	27.7%	29.0%	25.6%	23.8%
Percent of premiums in commercial lines short-tail	25.4%	33.5%	15.7%	18.2%***
Percent of premiums in commercial lines long-tail	37.6%	38.1%	47.5%	31.1%***
Product line Herfindahl, premium written	0.51	0.29	0.33	0.23***
Geographic Herfindahl, premiums written	0.65	0.37	0.28	0.3***
Percent of firms with NDRS (non-decreasing returns to scale)	57.4%	0.6%	12.6%	3.0%***
Percent unaffiliated companies	57.0%	0.6%	2.1%	1.0%***
Percent mutual companies	39.0%	0.6%	20.7%	3.4%***
Percent companies with A+ rating	15.9%	0.5%	41.1%	4.1%***
Percent companies with A or A-rating	53.6%	0.7%	50.4%	4.2%
Percent companies with B+ or B rating	30.5%	0.6%	8.5%	2.4%***
Efficiency scores				
Cost efficiency	0.49	0.18	0.52	0.16**
Technical efficiency	0.67	0.20	0.66	0.17
Allocative efficiency	0.74	0.16	0.79	0.14***
Pure technical efficiency	0.75	0.19	0.80	0.19***
Scale efficiency	0.89	0.13	0.84	0.12***
Revenue efficiency	0.44	0.22	0.40	0.17*
Malmquist index				
FGNZ Malmquist				
Observations [2]	4626		96	
Technical efficiency change	1.04	0.24	1.03	0.22
Technical change	1.01	0.18	0.99	0.14
Total factor productivity change	1.05	0.25	1.00	0.19*
Ray-Desli and Simar-Wilson Malmquist				
Observations	4562		92	
Pure technical efficiency change	1.02	0.21	1.03	0.19
Pure Technical change	1.42	1.23	1.38	1.22
Pure scale efficiency change	1.03	0.13	1.00	0.12**
Pure scale technical change	0.87	0.25	0.90	0.28
Efficiency change				
Observations	4629		96	
Cost efficiency	1.07	0.28	1.08	0.27
Allocative efficiency	1.06	0.41	1.06	0.56
Revenue efficiency	1.04	0.22	1.06	0.18

[1] The acquirers and non-acquirers analysis is at the group and unaffiliated single firm level. The acquirers category only includes firms that have passed our sample selection criteria for acquirers. The non-acquirers category has excluded all the target groups and unaffiliated firms, firms that sell subsidiaries, and firms that acquire but do not pass the sample selection criteria for being valid acquirers in this study.

[2] We observe a difference in sample size among FGNZ Malmquist, Ray-Desli and Simar-Wilson Malmquist, and Efficiency change because of the non-convergence of the DEA programs for some firms in the sample.

Note: Company characteristics and efficiency scores are one year prior to the M&A transactions.
Percent change in premiums t-2 to t-1 is defined as premiums at time t-1 divided by premiums at time t-2.
Malmquist index and efficiency change scores are over (t-1) and (t+2) window.
The efficiency change is defined as XE change = XE(t+2)/XE(t-1), where X = C = cost, X = A = allocative, and X = R = revenue.
Liquidity ratio = Invested assets in bonds, common stocks, cash and short-term investments / Total liabilities.
Loss & LAE indicates "Loss and loss adjustment expense".
***Significant at 1% level; **Significant at 5% level; *Significant at 10% level; they illustrate whether the difference between acquirers and non-acquirers is significant. Based on the Analysis of Variance.

Table 2
Summary Statistics For Targets and Non-targets [1], 1994-2003

Variable	Non-target firms		Target firms	
	Mean	Std. dev	Mean	Std. dev
Company Characteristics				
Observations	13976		241	
Total assets ($ million)	380.58	1226.79	381.28	959.39
Capital / total assets	0.44	0.20	0.38	0.19***
Liquidity ratio	1.65	0.73	1.47	0.66***
Operating cash flow / total assets	0.08	0.08	0.08	0.08
Premium / Surplus	1.18	0.81	1.34	0.85***
Loss & LAE reserves / surplus	1.02	0.90	1.36	1.00***
Return on asset	0.05	0.05	0.06	0.05
Return on equity (net income after tax/policyholder surplus)	0.10	0.08	0.11	0.09
Net income before tax / premium earned	0.32	1.08	0.38	1.92
Loss & LAE incurred / premiums earned	0.73	0.30	0.80	0.32***
Underwriting expense / premiums written	0.40	0.37	0.40	0.43
Invested income / premium earned	0.29	0.96	0.30	1.14
Invested assets / total assets	0.87	0.11	0.86	0.10*
Percent of invested assets in real estate	3.9%	4.2%	3.2%	3.4%
Percent of invested assets in stocks	18.1%	17.3%	15.3%	16.2%**
Percent of invested assets in bonds	70.9%	22.2%	72.5%	19.9%
Percent of invested assets in mortgages	2.3%	4.1%	1.2%	1.6%
Total Premiums ($ millions)	122.28	360.1	117.83	254.68
Percent change in premiums, t-2 to t-1	1.19	0.88	1.15	0.94
Percent of premiums in personal lines short-tail	10.3%	14.7%	11.9%	15.4%
Percent of premiums in personal lines long-tail	28.2%	28.3%	24.7%	26.9%*
Percent of premiums in commercial lines short-tail	22.6%	31.4%	17.7%	26.0%**
Percent of premiums in commercial lines long-tail	38.8%	36.9%	45.8%	36.4%***
Product line Herfindahl, premium written	0.48	0.29	0.44	0.27*
Geographic Herfindahl, premiums written	0.60	0.38	0.45	0.36***
Percent of firms with NDRS (non-decreasing returns to scale)	59.0%	0.4%	41.1%	3.2%***
Percent unaffiliated companies	32.9%	0.4%	13.3%	1.7%***
Percent mutual companies	25.5%	0.4%	5.0%	1.1%***
Percent companies with A+ rating	24.7%	0.4%	15.2%	2.4%***
Percent companies with A or A-rating	53.8%	0.5%	62.5%	3.2%***
Percent companies with B+ or B rating	21.6%	0.4%	22.3%	2.8%*
Efficiency scores				
Cost efficiency	0.43	0.18	0.45	0.16*
Technical efficiency	0.60	0.20	0.64	0.19***
Allocative efficiency	0.72	0.18	0.71	0.15
Pure technical efficiency	0.66	0.21	0.69	0.2**
Scale efficiency	0.91	0.12	0.93	0.08**
Revenue efficiency	0.35	0.21	0.39	0.21***
Malmquist indexes				
FGNZ Malmquist				
Observations [2]	9315		149	
Technical efficiency change	1.11	0.36	1.03	0.38**
Technical change	0.99	0.19	1.04	0.19***
Total factor productivity change	1.06	0.28	1.05	0.31
Ray-Desli and Simar-Wilson Malmquist				
Observations	9254		149	
Pure technical efficiency change	1.08	0.31	1.01	0.32**
Pure Technical change	2.08	1.75	2.44	1.97**
Pure scale efficiency change	1.03	0.14	1.01	0.12
Pure scale technical change	0.65	0.27	0.60	0.27**
Efficiency change				
Observations	9315		149	
Cost efficiency	1.17	0.52	1.14	0.55
Allocative efficiency	1.07	0.31	1.12	0.30**
Revenue efficiency	1.03	0.64	0.99	0.75

[1] The targets and non-targets analysis is at the individual firm level. The targets category includes all single firms that have passed our sample selection criteria; The non-target category has excluded the member companies of valid acquirers, member companies of firms that sell subsidiaries, and member companies of invalid acquirers (firms that acquire but do not pass the sample selection criteria for being valid acquirers in this study).
[2] We observe a difference in sample size among FGNZ Malmquist, Ray-Desli and Simar-Wilson Malmquist, and Efficiency change because of the non-convergence of the DEA programs for some firms in the sample.

Note: Company characteristics and efficiency scores are one year prior to the M&A transactions. Percent change in premiums t-2 to t-1 is defined as premiums at time t-1 divided by premiums at time t-2. Malmquist index and efficiency change scores are over (t-1) and (t+2) window.
The efficiency change is defined as XE change = XE(t+2)/XE(t-1), where X = C = cost, X = A = allocative, and X = R = revenue.
Liquidity ratio = Invested assets in bonds, common stocks, cash and short-term investments / Total liabilities.
Loss & LAE indicates "Loss and loss adjustment expense".
***Significant at 1% level; **Significant at 5% level; *Significant at 10% level; they illustrate whether the difference between acquirers and non-acquirers is significant. Based on the Analysis of Variance.

Table 3
Regression of Changes in Productivity and Efficiency for Acquirers and Non-acquirers [1]

Variables	Malmquist Indices—FGNZ			R-D and S-M Malmquist Indices				Efficiency Change (-1,+2) Year Window		
	TE Change	Tech Change	TFP Change	PTE Change	Pure Tech Change	Scale Tech Change	SE Change	CE	AE	RE
Acquirer	0.0036	-0.0102	-0.0129	0.0128	-0.2421	0.0385	-0.0106	0.0053	0.0064	0.0658
	(0.0246)	(0.0151)	(0.0263)	(0.0222)	(0.1009)**	(0.0143)***	(0.0137)	(0.0259)	(0.0219)	(0.0399)*
Ln(assets)	-0.0185	-0.0043	-0.0240	-0.0102	0.1121	-0.0149	-0.0072	-0.0165	0.0010	-0.0336
	(0.0026)***	(0.0016)***	(0.0028)***	(0.0024)***	(0.0108)***	(0.0015)***	(0.0015)***	(0.0028)***	(0.0023)	(0.0043)***
Mutual	-0.0385	-0.0003	-0.0457	-0.0183	-0.0865	0.0211	-0.0189	-0.0399	-0.0044	-0.0400
	(0.0079)***	(0.0048)	(0.0084)***	(0.0071)***	(0.0323)***	(0.0046)***	(0.0044)***	(0.0083)***	(0.0070)	(0.0128)***
Geographical Herfindahl	-0.0316	-0.0178	-0.0473	-0.0423	0.0021	-0.0126	0.0085	-0.0099	0.0178	-0.0916
	(0.0124)**	(0.0076)**	(0.0133)***	(0.0112)***	(0.0508)	(0.0072)*	(0.0069)	(0.0131)	(0.0110)	(0.0201)***
Unaffiliated company	-0.0115	-0.0005	-0.0180	-0.0144	-0.0199	0.0073	0.0040	-0.0265	-0.0152	0.0070
	(0.0094)	(0.0058)	(0.0101)*	(0.0085)*	(0.0387)	(0.0055)	(0.0052)	(0.0099)***	(0.0084)*	(0.0153)
Pct PST premiums	0.0584	-0.0735	0.0102	0.0468	0.1413	-0.0237	0.0070	0.0518	-0.0295	0.1675
	(0.0280)**	(0.0172)***	(0.0300)	(0.0253)*	(0.1148)	(0.0163)	(0.0156)	(0.0295)*	(0.0249)	(0.0455)***
Pct PLT premiums	0.0146	0.0385	0.0675	0.0537	0.0638	0.0201	-0.0453	0.0192	-0.0126	0.1558
	(0.0171)	(0.0105)***	(0.0182)***	(0.0154)***	(0.0699)	(0.0099)**	(0.0095)***	(0.0180)	(0.0152)	(0.0277)***
Pct CLT premiums	0.0539	-0.0427	0.0190	0.0527	-0.1475	0.0102	-0.0036	0.1165	0.0574	0.1243
	(0.0128)***	(0.0078)***	(0.0136)	(0.0115)***	(0.0523)***	(0.0074)	(0.0071)	(0.0134)***	(0.0113)***	(0.0207)***
Product line Herfindahl	-0.0377	0.0000	-0.0363	-0.0201	-0.0273	0.0121	-0.0139	-0.0537	-0.0065	-0.0500
	(0.0148)**	(0.0091)	(0.0158)**	(0.0134)	(0.0607)	(0.0086)	(0.0082)*	(0.0156)***	(0.0132)	(0.0240)**
Premium/surplus ratio	-0.0540	0.0040	-0.0490	-0.0314	-0.0961	0.0164	-0.0240	-0.0138	0.0342	-0.0537
	(0.0051)***	(0.0031)	(0.0054)***	(0.0046)***	(0.0207)***	(0.0029)***	(0.0028)***	(0.0053)***	(0.0045)***	(0.0082)***
1995 dummy	-0.0978	0.0558	-0.0214	-0.0446	-2.2030	0.5688	-0.0619	-0.2145	-0.1270	-0.5151
	(0.0131)***	(0.0081)***	(0.0140)	(0.0118)***	(0.0538)***	(0.0076)***	(0.0073)***	(0.0138)***	(0.0117)***	(0.0213)***
1996 dummy	-0.0748	0.0084	-0.0363	-0.0432	-2.2394	0.5372	-0.0377	-0.0123	0.0408	-0.3329
	(0.0133)***	(0.0081)	(0.0142)**	(0.0119)***	(0.0543)***	(0.0077)***	(0.0074)***	(0.0139)	(0.0118)***	(0.0215)***
1997 dummy	-0.0790	0.0068	-0.0446	-0.0201	-1.5843	0.2080	-0.0673	-0.0416	0.0174	-0.3631
	(0.0133)***	(0.0081)	(0.0142)***	(0.0120)*	(0.0544)***	(0.0077)***	(0.0074)***	(0.0140)***	(0.0118)	(0.0216)***
1998 dummy	-0.0253	-0.0211	-0.0333	0.0126	-2.2729	0.5405	-0.0490	0.0978	0.0821	0.0263
	(0.0135)*	(0.0083)**	(0.0145)**	(0.0122)	(0.0554)***	(0.0079)***	(0.0075)***	(0.0143)***	(0.0120)***	(0.0219)
1999 dummy	-0.1175	0.0961	0.0096	-0.0332	-2.2021	0.5732	-0.0952	-0.1543	-0.0631	-0.3860
	(0.0137)***	(0.0084)***	(0.0146)	(0.0124)***	(0.0561)***	(0.0080)***	(0.0076)***	(0.0144)***	(0.0122)***	(0.0222)***
2000 dummy	-0.2225	0.2528	0.0449	-0.1208	-2.0471	0.5721	-0.1099	-0.3175	-0.1223	-0.4082
	(0.0138)***	(0.0085)***	(0.0148)***	(0.0125)***	(0.0566)***	(0.0080)***	(0.0077)***	(0.0145)***	(0.0123)***	(0.0224)***
2001 dummy	-0.1857	0.2549	0.0908	-0.0835	-2.0413	0.5649	-0.1126	-0.2786	-0.1133	-0.3154
	(0.0138)***	(0.0084)***	(0.0147)***	(0.0124)***	(0.0563)***	(0.0080)***	(0.0076)***	(0.0145)***	(0.0122)***	(0.0223)***
Constant	1.5708	1.0323	1.5855	1.2910	1.4028	0.6611	1.2734	1.5073	1.0046	2.0009
	(0.0545)***	(0.0334)***	(0.0582)***	(0.0491)***	(0.2230)***	(0.0316)***	(0.0302)***	(0.0573)***	(0.0484)***	(0.0883)***
No. of obs.	4461	4461	4461	4461	4461	4461	4461	4461	4461	4461
Adjusted R-square	0.11	0.37	0.07	0.05	0.41	0.72	0.11	0.27	0.15	0.22

[1] This table presents regression analysis of productivity and efficiency changes from t-1 to t+2 for acquirers and non-acquirers during the period 1994-2001.The acquirers category only includes groups and unaffiliated companies that have passed our sample selection criteria for acquirers. The non-acquirers category has excluded all the target groups and unaffiliated firms, firms that sell subsidiaries, and firms that acquire but do not pass the sample selection criteria for being valid acquirers in this study.

The dependent variables are productivity changes (with its various decompositions) and efficiency changes. Among them, TE change and Tech Change (technical change) are FGNZ decomposition of the Malmquist Index of TFP (Total factor productivity). PTE change, Pure tech change, scale tech change and SE change are R-D and S-M components of the Malmquist Index of TFP. TE: technical efficiency; PTE: pure technical efficiency; SE: scale efficiency; CE: cost efficiency; AE: allocative efficiency; RE: revenue efficiency.

The efficiency change is defined as XE change = XE(t+2)/XE(t-1), where X = C = cost, X = A = allocative, and X = R = revenue.

PST: personal lines short-tail; PLT: personal lines long-tail; CLT: Commercial lines long-tail. The values of independent variables are values one year prior to the M&A transactions; ***Significant at 1% level; **Significant at 5% level; *Significant at 10% level; Standard errors in parentheses.

Table 4
Regression of Changes in Productivity and Efficiency for Targets and Non-targets [1]

Variables	Malmquist Indices—FGNZ			R-D and S-M Malmquist Indices				Efficiency Change (-1,+2) Year Window		
	TE Change	Tech Change	TFP Change	PTE Change	Pure Tech Change	Scale Tech Change	SE Change	CE	AE	RE
Target company	-0.0028	0.0013	-0.0149	-0.0136	-0.1845	0.0189	0.0044	0.0648	0.0600	-0.0032
	(0.0264)	(0.0117)	(0.0230)	(0.0243)	(0.1184)	(0.0152)	(0.0111)	(0.0390)*	(0.0255)**	(0.0475)
Ln(assets)	-0.0242	-0.0018	-0.0220	-0.0307	0.4779	-0.0559	0.0090	-0.0243	0.0007	-0.0296
	(0.0023)***	(0.0010)*	(0.0020)***	(0.0021)***	(0.0103)***	(0.0013)***	(0.0010)***	(0.0034)***	(0.0022)	(0.0041)***
Mutual	-0.0250	-0.0051	-0.0358	-0.0292	0.0451	-0.0113	0.0071	-0.0245	-0.0030	-0.0566
	(0.0083)***	(0.0036)	(0.0072)***	(0.0076)***	(0.0370)	(0.0047)**	(0.0035)**	(0.0122)**	(0.0080)	(0.0149)***
Geographical Herfindahl	-0.0225	-0.0002	-0.0141	-0.0304	0.2859	-0.0304	0.0030	-0.0034	0.0197	-0.0479
	(0.0111)**	(0.0049)	(0.0097)	(0.0102)***	(0.0497)***	(0.0064)***	(0.0047)	(0.0164)	(0.0107)*	(0.0199)**
Unaffiliated company	-0.0285	-0.0055	-0.0347	-0.0274	0.1609	-0.0152	-0.0022	-0.0395	-0.0155	-0.0200
	(0.0085)***	(0.0037)	(0.0074)***	(0.0078)***	(0.0379)***	(0.0049)***	(0.0035)	(0.0125)***	(0.0082)*	(0.0152)
Pct PST premiums	0.0811	-0.0289	0.0227	0.0653	0.4951	-0.0306	0.0093	0.0365	-0.1054	0.3383
	(0.0279)***	(0.0123)**	(0.0243)	(0.0256)**	(0.1250)***	(0.0160)*	(0.0117)	(0.0411)	(0.0269)***	(0.0502)***
Pct PLT premiums	0.2529	-0.1557	0.0570	0.2087	-0.1444	-0.0223	0.0310	0.3117	-0.0213	0.2266
	(0.0167)***	(0.0074)***	(0.0145)***	(0.0153)***	(0.0747)*	(0.0096)**	(0.0070)***	(0.0246)***	(0.0161)	(0.0300)***
Pct CLT premiums	0.0790	-0.0733	0.0204	0.0944	-0.8500	0.0895	-0.0182	0.0083	-0.0631	0.1387
	(0.0130)***	(0.0057)***	(0.0113)*	(0.0119)***	(0.0582)***	(0.0075)***	(0.0054)***	(0.0192)	(0.0125)***	(0.0234)***
Product line Herfindahl	0.0191	0.0128	0.0230	0.0035	0.4446	-0.0593	0.0162	0.0816	0.0475	0.1567
	(0.0136)	(0.0060)**	(0.0118)*	(0.0125)	(0.0608)***	(0.0078)***	(0.0057)***	(0.0200)***	(0.0131)***	(0.0244)***
Premium / surplus ratio	-0.0659	0.0099	-0.0554	-0.0605	-0.1348	0.0190	-0.0043	-0.0187	0.0418	-0.0097
	(0.0046)***	(0.0020)***	(0.0040)***	(0.0042)***	(0.0204)***	(0.0026)***	(0.0019)**	(0.0067)***	(0.0044)***	(0.0082)
1995 dummy	-0.3154	0.1482	-0.0171	-0.1093	-1.2959	0.4196	-0.1845	-0.5731	-0.1385	-1.0186
	(0.0128)***	(0.0056)***	(0.0111)	(0.0117)***	(0.0572)***	(0.0073)***	(0.0054)***	(0.0188)***	(0.0123)***	(0.0230)***
1996 dummy	-0.4032	0.1982	-0.0310	-0.1891	-0.0482	0.0922	-0.1904	-0.6411	-0.1276	-1.0714
	(0.0128)***	(0.0056)***	(0.0111)***	(0.0117)***	(0.0572)	(0.0073)***	(0.0054)***	(0.0188)***	(0.0123)***	(0.0230)***
1997 dummy	-0.4627	0.2332	-0.0430	-0.2404	-1.1090	0.3092	-0.1997	-0.7143	-0.1288	-1.0555
	(0.0128)***	(0.0056)***	(0.0111)***	(0.0117)***	(0.0571)***	(0.0073)***	(0.0053)***	(0.0188)***	(0.0123)***	(0.0229)***
1998 dummy	-0.4856	0.2654	-0.0295	-0.2589	-0.1280	0.2037	-0.2014	-0.6123	-0.0170	-0.8279
	(0.0129)***	(0.0057)***	(0.0113)***	(0.0119)***	(0.0580)**	(0.0074)***	(0.0054)***	(0.0191)***	(0.0125)	(0.0233)***
1999 dummy	-0.5309	0.3450	0.0047	-0.2985	0.1379	0.1239	-0.2063	-0.7639	-0.1224	-0.8346
	(0.0131)***	(0.0058)***	(0.0114)	(0.0120)***	(0.0585)**	(0.0075)***	(0.0055)***	(0.0193)***	(0.0126)***	(0.0235)***
2000 dummy	-0.5665	0.4405	0.0621	-0.3115	0.3655	0.1109	-0.2274	-0.8920	-0.2035	-0.8174
	(0.0134)***	(0.0059)***	(0.0116)***	(0.0123)***	(0.0598)***	(0.0077)***	(0.0056)***	(0.0197)***	(0.0129)***	(0.0240)***
2001 dummy	-0.5095	0.3971	0.0820	-0.2673	-1.4039	0.5689	-0.2150	-0.7995	-0.1759	-0.9341
	(0.0130)***	(0.0057)***	(0.0113)***	(0.0119)***	(0.0580)***	(0.0074)***	(0.0054)***	(0.0191)***	(0.0125)***	(0.0233)***
Constant	1.9326	0.8353	1.5096	1.8340	-6.0408	1.4284	1.0353	2.1357	1.1282	2.2126
	(0.0454)***	(0.0200)***	(0.0396)***	(0.0417)***	(0.2035)***	(0.0261)***	(0.0191)***	(0.0670)***	(0.0438)***	(0.0817)***
No. of obs.	8739	8739	8739	8739	8739	8739	8739	8739	8739	8738
Adjusted R-square	0.27	0.51	0.07	0.15	0.36	0.57	0.24	0.27	0.06	0.28

[1] This table presents regression analysis of productivity and efficiency changes from t-1 to t+2 for targets and non-targets during the period 1994-2001.The targets category includes all single firms that have passed our sample selection criteria; The non-target category has excluded the member companies of valid acquirers, member companies of firms that sell subsidiaries, and member companies of invalid acquirers (firms that acquire but do not pass the sample selection criteria for being valid acquirers in this study).

The dependent variables are productivity changes (with its various decompositions) and efficiency changes. Among them, TE change and Tech Change (technical change) are FGNZ decomposition of the Malmquist Index of TFP (Total factor productivity). PTE change, Pure tech change, scale tech change and SE change are R-D and S-M components of the Malmquist Index of TFP. TE: technical efficiency; PTE: pure technical efficiency; SE: scale efficiency; CE: cost efficiency; AE: allocative efficiency; RE: revenue efficiency.

The efficiency change is defined as XE change = XE(t+2)/XE(t-1), where X = C = cost, X = A = allocative, and X = R = revenue.

PST: personal lines short-tail; PLT: personal lines long-tail; CLT: Commercial lines long-tail. The values of independent variables are values one year prior to the M&A transactions; ***Significant at 1% level; **Significant at 5% level; *Significant at 10% level; Standard errors in parentheses.

Table 5
Probit Analysis—the Probability of Being an Acquirer [1]

	Efficiency Variable				
	CE	**TE**	**PTE**	**AE**	**RE**
NDRS (non-decreasing returns to scale) dummy	-0.1705	-0.1376	-0.1593	-0.1941	-0.1944
	(0.1787)	(0.1806)	(0.1748)	(0.1731)	(0.1767)
Pct changes in premiums	0.1191	0.1260	0.1274	0.1262	0.1208
	(0.0972)	(0.0973)	(0.0985)	(0.0957)	(0.0960)
Efficiency	-0.3565	-0.5436	-0.7413	0.3156	-0.0380
	(0.5985)	(0.4750)	(0.4466)*	(0.5264)	(0.4032)
Capital / asset	-0.4052	-0.4738	-0.5348	-0.4166	-0.3931
	(0.5828)	(0.5908)	(0.5986)	(0.5873)	(0.5910)
Ln(assets)	0.1780	0.1821	0.2177	0.1684	0.1705
	(0.0396)***	(0.0389)***	(0.0474)***	(0.0375)***	(0.0374)***
Mutual	-0.0898	-0.0866	-0.0848	-0.0987	-0.0953
	(0.1263)	(0.1263)	(0.1266)	(0.1261)	(0.1265)
Geographic Herfindahl	-0.0181	-0.0093	0.0064	-0.0432	-0.0353
	(0.2078)	(0.2072)	(0.2072)	(0.2049)	(0.2054)
Unaffiliated company	-0.7050	-0.6968	-0.6688	-0.6951	-0.7007
	(0.2244)***	(0.2243)***	(0.2249)***	(0.2245)***	(0.2243)***
Pct PST premiums	0.2189	0.2617	0.2492	0.0811	0.1156
	(0.6746)	(0.6678)	(0.6747)	(0.6476)	(0.6481)
Pct PLT premiums	0.4993	0.4857	0.4398	0.4053	0.4437
	(0.4065)	(0.4012)	(0.4046)	(0.4030)	(0.4018)
Pct CLT premiums	0.5287	0.5245	0.4772	0.5617	0.5525
	(0.3044)*	(0.3040)*	(0.3068)	(0.3010)*	(0.3012)*
Product line Herfindahl	0.0040	0.0332	0.0512	-0.0246	-0.0209
	(0.2565)	(0.2570)	(0.2566)	(0.2515)	(0.2618)
Net income before tax / policyholder surplus	0.7975	0.8455	0.8608	0.8145	0.7980
	(0.4250)*	(0.4261)**	(0.4224)**	(0.4467)*	(0.4377)*
Loss & LAE incurred / premiums earned	0.0495	0.0881	0.1191	-0.0761	-0.0227
	(0.4181)	(0.4082)	(0.4039)	(0.4061)	(0.4138)
Underwriting expenses / premiums written	0.3882	0.4046	0.4291	0.4522	0.4184
	(0.2542)	(0.2525)	(0.2524)*	(0.2528)*	(0.2484)*
Pct investment in stock	0.6847	0.6398	0.6355	0.7074	0.7224
	(0.4335)	(0.4353)	(0.4360)	(0.4298)*	(0.4284)*
1995 dummy	0.2279	0.2520	0.2728	0.2689	0.2431
	(0.2555)	(0.2556)	(0.2556)	(0.2594)	(0.2556)
1996 dummy	0.2960	0.3224	0.3412	0.3328	0.3073
	(0.2482)	(0.2491)	(0.2492)	(0.2526)	(0.2487)
1997 dummy	-0.0158	0.0184	0.0268	0.0151	-0.0091
	(0.2678)	(0.2699)	(0.2690)	(0.2721)	(0.2698)
1998dummy	0.3957	0.4282	0.4439	0.4422	0.4080
	(0.2395)*	(0.2404)*	(0.2402)*	(0.2462)*	(0.2390)*
1999 dummy	0.3268	0.3455	0.3420	0.3140	0.3113
	(0.2464)	(0.2476)	(0.2457)	(0.2454)	(0.2452)
2000 dummy	0.4700	0.4868	0.4779	0.4502	0.4509
	(0.2480)*	(0.2486)*	(0.2464)*	(0.2460)*	(0.2465)*
2001 dummy	0.0210	0.0402	0.0280	-0.0015	-0.0006
	(0.2790)	(0.2803)	(0.2785)	(0.2773)	(0.2769)
2002dummy	-0.0861	-0.0761	-0.0866	-0.1101	-0.1079
	(0.3180)	(0.3184)	(0.3175)	(0.3171)	(0.3162)
Intercept	-6.1423	-6.0995	-6.5989	-6.2854	-6.0981
	(0.9275)***	(0.9299)***	(0.9826)***	(0.9768)***	(0.9257)***
No. of observations	4072	4072	4072	4072	4072
Log-likelihood	-333.2	-332.7	-331.9	-333.2	-333.3

[1] This table presents probit analysis to test the likelihood of being an acquirer during the period 1994-2003. The dependent variable is 1 if a firm is an acquirer and 0 if a firm is a non-acquirer; The acquirers category includes groups and unaffiliated companies that have passed our sample selection criteria for acquirers. The non-acquirers category has excluded all the target groups and unaffiliated firms, firms that sell subsidiaries, and firms that acquire but do not pass the sample selection criteria for being valid acquirers in this study.
The values of independent variables are values one year prior to the M&A transactions (i.e. year t-1 value); TE: technical efficiency; PTE: pure technical efficiency; CE: cost efficiency; AE: allocative efficiency; RE: revenue efficiency. Only one types of the efficiency is used for each regression because of their high correlation with each other. PST: personal lines short-tail; PLT: personal lines long-tail; CLT: Commercial lines long-tail.

***Significant at 1% level; **Significant at 5% level; *Significant at 10% level; Standard errors in parentheses.

Table 6
Probit Analysis—the Probability of Being a Target [1]

	Efficiency Variable				
	CE	**TE**	**PTE**	**AE**	**RE**
NDRS (non-decreasing returns to scale) dummy	-0.2046	-0.2134	-0.2153	-0.2151	-0.2309
	(0.1206)*	(0.1200)*	(0.1194)*	(0.1194)*	(0.1196)*
Pct changes in premiums	0.0069	0.0160	0.0164	0.0163	0.0244
	(0.0821)	(0.0799)	(0.0799)	(0.0783)	(0.0771)
Efficiency	-0.7996	-0.3412	-0.3438	-0.3877	0.3071
	(0.4652)*	(0.3545)	(0.3199)	(0.3654)	(0.2678)
Capital / asset	-0.8024	-0.8406	-0.8317	-0.6258	-0.6387
	(0.3703)**	(0.3915)**	(0.3859)**	(0.3729)*	(0.3732)*
Ln(assets)	-0.0542	-0.0640	-0.0543	-0.0666	-0.0716
	(0.0418)	(0.0413)	(0.0436)	(0.0406)	(0.0405)*
Mutual	-0.5781	-0.5848	-0.5845	-0.5798	-0.5858
	(0.1507)***	(0.1508)***	(0.1509)***	(0.1510)***	(0.1512)***
Geographic Herfindahl	-0.4711	-0.4665	-0.4617	-0.4875	-0.4948
	(0.1513)***	(0.1513)***	(0.1513)***	(0.1512)***	(0.1517)***
Unaffiliated company	-0.0266	-0.0184	-0.0130	-0.0271	-0.0252
	(0.1209)	(0.1208)	(0.1208)	(0.1209)	(0.1210)
Pct PST premiums	1.3519	1.1551	1.1556	1.1283	0.9649
	(0.4113)***	(0.3841)***	(0.3810)***	(0.3721)***	(0.3641)***
Pct PLT premiums	0.6515	0.4655	0.4540	0.5162	0.3956
	(0.3086)**	(0.2777)*	(0.2745)*	(0.2894)*	(0.2652)
Pct CLT premiums	0.4794	0.4151	0.4120	0.4597	0.3778
	(0.2309)**	(0.2256)*	(0.2253)*	(0.2307)**	(0.2225)*
Product line Herfindahl	0.3374	0.3315	0.3337	0.2577	0.2125
	(0.1810)*	(0.1847)*	(0.1840)*	(0.1807)	(0.1902)
Net income before tax / policyholder surplus	0.4437	0.4491	0.4476	0.4218	0.4047
	(0.2499)*	(0.2530)*	(0.2521)*	(0.2499)*	(0.2535)
Loss & LAE incurred / premiums earned	0.6836	0.6449	0.6370	0.5880	0.5181
	(0.2753)**	(0.2782)**	(0.2750)**	(0.2679)**	(0.2747)*
Underwriting expenses / premiums written	0.3139	0.3838	0.3932	0.3591	0.4242
	(0.2381)	(0.2239)*	(0.2252)*	(0.2166)*	(0.2057)**
Pct investment in stock	-0.0078	0.0413	0.0476	0.0690	0.0691
	(0.3052)	(0.3035)	(0.3027)	(0.2984)	(0.2990)
1995 dummy	-0.2230	-0.2135	-0.2088	-0.2026	-0.2229
	(0.2537)	(0.2533)	(0.2533)	(0.2549)	(0.2561)
1996 dummy	0.1606	0.1560	0.1589	0.1594	0.1375
	(0.2145)	(0.2134)	(0.2136)	(0.2151)	(0.2156)
1997 dummy	0.2745	0.2571	0.2593	0.2622	0.2339
	(0.2096)	(0.2084)	(0.2086)	(0.2101)	(0.2106)
1998dummy	0.3575	0.3488	0.3467	0.3300	0.3367
	(0.2052)*	(0.2044)*	(0.2044)*	(0.2054)	(0.2057)
1999 dummy	0.6711	0.6355	0.6306	0.6274	0.6175
	(0.1992)***	(0.1967)***	(0.1962)***	(0.1975)***	(0.1975)***
2000 dummy	0.7240	0.6798	0.6804	0.6939	0.6791
	(0.2011)***	(0.1979)***	(0.1980)***	(0.2006)***	(0.1998)***
2001 dummy	-0.2008	-0.2629	-0.2621	-0.2358	-0.2652
	(0.2797)	(0.2771)	(0.2771)	(0.2783)	(0.2778)
2002dummy	-0.5147	-0.5503	-0.5508	-0.5286	-0.5530
	(0.3825)	(0.3802)	(0.3803)	(0.3823)	(0.3828)
Intercept	-1.6578	-1.5110	-1.6752	-1.4137	-1.5685
	(0.9041)*	(0.9020)*	(0.9119)*	(0.8997)	(0.8902)*
No. of observations	6586	6586	6586	6586	6586
Log-likelihood	-475.9	-476.9	-476.8	-476.9	-476.8

[1] This table presents probit analysis to test the likelihood of being a target during the period 1994-2003. The dependent variable is 1 if a firm is a target and 0 if a firm is a non-target; The targets category includes all single firms that have passed our sample selection criteria; The non-target category has excluded the member companies of valid acquirers, member companies of firms that sell subsidiaries, and member companies of invalid acquirers (firms that acquire but do not pass the sample selection criteria for being valid acquirers in this study).

The values of independent variables are values one year prior to the M&A transactions (i.e. year t-1 value); TE: technical efficiency; PTE: pure technical efficiency; CE: cost efficiency; AE: allocative efficiency; RE: revenue efficiency. Only one types of the efficiency is used for each regression because of their high correlation with each other. PST: personal lines short-tail; PLT: personal lines long-tail; CLT: Commercial lines long-tail.

***Significant at 1% level; **Significant at 5% level; *Significant at 10% level; Standard errors in parentheses.

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