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An Empirical Investigation of Market Structure, Efficiency, and Performance in Property-Liability Insurance

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Abstract

This study examines the relationships among market structure and performance in property-liability insurers over the period 1992–1998 using data at the company and group levels. Three specific hypotheses are tested: traditional structure-conduct-performance, relative market power, and efficient structure (ES). The results provide support for the ES hypothesis. The ES hypothesis posits that more efficient firms can charge lower prices than competitors, enabling them to capture larger market shares and economic rents, leading to increased concentration. Both revenue and cost efficiency are used in the analysis, and this is the first study to use revenue efficiency in this type of analysis. The results for the sample period as a whole and by year are consistent. The overall results suggest that cost-efficient firms charge lower prices and earn higher profits, in conformance with the ES hypothesis. On the other hand, prices and profits are found to be higher for revenue-efficient firms. Revenue X-efficiency is derived from activities such as cross-selling and may rely heavily on the use of detailed information from customer databases to identify potential customers. The implications of this research are that regulators should be more concerned with efficiency (both cost and revenue) rather than the market power that arises from the consolidation activity taking place in insurance.

Introduction

The financial services industry is in the midst of consolidation and restructuring worldwide. Financial services firm consolidation in the United States has accelerated owing to technological progress and deregulation (e.g., Gramm-Leach-Bliley Act of 1999). Consolidation impacts competition and the economic performance of

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the industry. U.S. antitrust policy is primarily concerned with preventing mergers and acquisitions that would significantly impact market power (e.g., the potential for collusive behavior within the industry). So, a public policy question arises as to the effect of consolidation on consumers and whether antitrust or other regulatory actions should be pursued by government.

The traditional structure-conduct-performance (SCP) hypothesis suggests a positive relationship between performance and concentration. That is, market concentration may foster collusion among firms in the market since higher concentration lowers the cost of collusion, resulting in monopoly rents (Weiss, 1974). Consequently, the traditional SCP hypothesis and some existing structure-performance studies provide an argument for antitrust policy prohibiting actions leading to a reduced number of viable competitors. However, the SCP hypothesis has been challenged and developed further by an alternative view, the efficient-structure (ES) paradigm. According to the argument that traditional SCP ignores the possibility of entry, the ES paradigm posits that more efficient firms charge lower prices than competitors, enabling them to capture a larger market share and economic rents, leading to increased concentration (e.g., Demsetz, 1973, 1974, Peltzman, 1977, and Brozen, 1982).

The ES hypothesis holds that higher concentration may benefit both the firm and consumer in the form of higher profits and reduced prices. Although earlier tests of the ES hypothesis in the financial services sector used proxy variables to represent firm efficiency, Berger and Hannan (1993) innovated by including a direct measure of efficiency in their empirical test. More recent papers also take this approach (e.g., Berg and Kim, 1994; Berger, 1995; Goldberg and Rai, 1996; Nickell, 1996; Maudos, 1998). Berger and Hannan (1993) include market concentration and firm-specific efficiency variables in their models.

Relatively little prior insurance research examining the SCP relationship exists, and the results of these studies conflict with each other (e.g., Carroll, 1993; Bajtelsmit and Bouzouita, 1998; Chidambaran, Pugel, and Saunders, 1997). Moreover, no SCP studies in the insurance industry explicitly measure the effects of efficiency on performance. The purpose of this research is to investigate the performance-structure relationship for the property-liability insurance industry. Firm-specific data for 1992–1998 are analyzed, a more extensive data set than that used in previous insurance studies. Explicit estimates of X-efficiency (estimated from a stochastic frontier approach [SFA]) are incorporated in the models. Furthermore, revenue efficiency as well as cost efficiency are included in the models to capture the effect of both types of efficiency, and this is the first research to use both types of efficiency measures in this type of analysis. The structure-performance relationship is investigated using two different performance measures, price and profit, to provide evidence on whether consolidation benefits consumers as well as firms.

The results of this article provide important input into public policy issues such as antitrust. If the traditional SCP hypothesis or the RMP hypothesis is supported in the empirical tests, then the merger and acquisition activities in the insurance industry may lead to collusive prices that are higher than competitive rates. On the other hand, if efficiency leads firms to increase market share and profits, then regulators should focus on whether insurers share their gains from efficiency with consumers in the form of lower prices.

This article is organized as follows: the first section reviews structure-performance studies in the banking and insurance industry. In the next section, model specification and hypothesis tests are considered. Following this, the methodology is presented. Sample selection and data are discussed in the next section. Then the results are discussed, followed by the conclusion.

LITERATURE REVIEW

The traditional SCP approach addresses the relationship between structure and performance via the conduct of the firms in the market (Mason, 1939; Bain, 1951). Stigler (1964) made an important contribution to this literature by suggesting that effective collusion of firms increases with market concentration, and collusion then determines firms' performance. As a result, firms are hypothesized to enjoy joint profit maximization in a concentrated market.

The potential role of market share on profit and prices is analyzed by Rhoades (1985). Under the relative market power (RMP) hypothesis, consumers differentiate the products of large firms from smaller firms.[1] This product differentiation does not have to be real; it must merely be perceived. Inherent product differentiation exists when customers follow a "herd" instinct and purchase products from the market leader to be "just like everyone else"; or customers may rely on the market leader's position as an indicator of quality and save search costs. Advertising efforts in which a firm touts its position as a market leader is consistent with the RMP hypothesis. In banking, Berger (1995) identifies RMP with factors such as better location (of bank branches) and higher service quality.

An important contribution to structure-performance studies is the ES hypothesis proposed by Demsetz (1973, 1974) and Peltzman (1977). The ES hypothesis suggests that the structure of the market in which a firm operates is also determined by efficiency.[2] In this alternative paradigm, higher profits are earned by relatively more efficient firms, and since concentration is a by-product of efficiency, these profit gains are viewed as economic rents rather than monopoly rents.

Empirical applications of both theories have been the subject of many studies in the banking industry, while a small number of insurance studies examine them. The most recent banking studies consider the effects of efficiency on the SCP relationship (e.g., Gilbert, 1984; Smirlock, 1985; Evanoff and Fortier, 1988; Lloyd-Williams, Molyneux, and Thornton, 1994; Molyneux and Forbes, 1995; Berger and Hannan, 1993; Berg and Kim, 1994; Berger, 1995; Goldberg and Rai, 1996; Berger and Hannan, 1998; Maudos, 1998). However, these studies differ as to whether efficiency is estimated directly or indirectly (i.e., by proxy variable). Furthermore, the methodology used to estimate efficiency varies among the studies, as well as control variables in the models. Thus, the results from the banking studies are mixed. Nevertheless, most recent banking

[1] Under the RMP hypothesis, "firms [are] perceived to be better simply by virtue of their position in the market" (Rhoades, 1985, p. 359).

[2] The researchers who support the efficient-structure paradigm criticize the traditional market power paradigm because relationships between market share, concentration, and efficiency are not taken into consideration (see Peltzman, 1977).

studies incorporating explicit measures of efficiency in the analysis tend to find some support for the ES hypothesis.

In contrast to banking, there are only a handful of studies that analyze the relationship between market characteristics and market performance in the insurance industry. But the results of these studies are inconsistent. Jung (1987) and Carroll (1993) found weak or no support for SCP, while Chidambaran, Pugel, and Saunders (1997) and Bajtelsmit and Bouzouita (1998) found some evidence in support of SCP (i.e., concentration is related to higher profitability).

While most banking studies in this area focus on individual banks as a unit of analysis, most insurance studies use data aggregated to the state level (Carroll, 1993; Bajtelsmit and Bouzouita, 1998) or annual national data (Chidambaran, Pugel, and Saunders, 1997). In the context of the SCP and ES hypotheses, Carroll (1993) and Bajtelsmit and Bouzouita (1998) are the only studies that explicitly allow for the effect of efficiency on performance. However, both studies utilize an indirect efficiency measure, direct writer market share, as a proxy for efficiency, rather than an explicit efficiency measure.[3]

Carroll (1993) examines the relationship between market characteristics and market performance for workers' compensation insurance. In this study, pooled cross-sectional time series data are used, where the unit is state-years, for the period 1980–1987. Assuming that the rating bureau acts as a cartel, Carroll (1993) suggests that the degree of adherence to rates proposed by the bureau can be a proxy measure for collusion, with a lower degree of adherence to the rates associated with less collusive behavior. However, Carroll's empirical results do not fully support either the RMP or ES hypotheses.

Bajtelsmit and Bouzouita (1998) analyze the interdependence of concentration and profitability in the market for private passenger automobile insurance. Bajtelsmit and Bouzouita (1998) examine personal auto insurance data aggregated to the state level for the period 1984 to 1992. They argue that a state market is more appropriate to analyze than a national market, because insurance regulation, concentration ratios, and marketing of auto insurance to consumers all vary by state. Industry profitability is used as a measure of performance, and the direct writers' market share is used as a proxy for efficiency (i.e., delivery system efficiency). But the results show no significant association between profitability and the share of direct writers in automobile insurance. The evidence examined by Bajtelsmit and Bouzouita (1998) is consistent with the SCP hypothesis, as positive and significant relationships between concentration (as measured by the Herfindahl index) and profits are found for liability, physical damage, and the combined lines.[4]

[3] Berger, et al. (2000) also consider the relationship between efficiency and performance in the context of economies of scope in the insurance industry.

[4] In another study of automobile residual market shares, Bouzouita and Bajtelsmit (1997) find a negative relationship between automobile residual market share and concentration in a state. They hypothesize that this might occur because insurers have size-related information and efficiency advantages. Although they point out also that this effect could be due to reduced loss-spreading benefits when there are a few, large insurers in the state.

None of the prior insurance studies incorporates an explicit measure of efficiency in the testing hypothesis about market structure and performance. The inconsistent empirical results and the lack of explicit control for efficiency on market performance and conduct provide the motivation for this study.

MODEL SPECIFICATION AND HYPOTHESIS TESTS

This article analyzes the relationship between firm performance and market structure and efficiency. Direct measures of cost and revenue efficiency are incorporated in the models; and this study innovates by including a measure of revenue efficiency in the analysis.[5] Following Berger and Hannan (1993), profitability and price models are estimated. This article tests three specific hypotheses: SCP, RMP, and ES. To analyze the ES hypothesis, efficiency is decomposed into cost (revenue) X-efficiency and cost (revenue) scale-efficiency. The X-efficient-structure (ESX) hypothesis posits that X-efficiency is related to profit and prices, while the scale efficient-structure (ESS) hypothesis suggests that *scale* efficiency is an important determinant of prices and profit. (See also Berger, 1995; Goldberg and Rai, 1996.) Thus, to test the overall ES hypothesis, the relationships between X-efficiency and prices and profit are examined separately from the relationships of scale efficiency with prices and profit.

Relationship Between Price, Profit, and Performance

To test the SCP, RMP, ESX, and ESS hypotheses, two main equations are estimated:

$$\begin{aligned} Profit_{ist} = {} & \beta_0 + \beta_1 Concentration_{st} + \beta_2 Market\ Share_{ist} + \beta_3 Cost\,X - Efficiency_{it} \\ & + \beta_4 Cost\ Scale\ Efficiency_{it} + \beta_5 Revenue\ X - Efficiency_{it} \\ & + \beta_6 Revenue\ Scale\ Efficiency_{it} + \gamma' X_{ist} + \varepsilon_{ist} \end{aligned} \tag{1}$$

$$\begin{aligned} Price_{ist} = {} & \delta_0 + \delta_1 Concentration_{st} + \delta_2 Market\ Share_{ist} + \delta_3 Cost\,X - Efficiency_{it} \\ & + \delta_4 Cost\ Scale\ Efficiency_{it} + \delta_5 Revenue\,X - Efficiency_{it} \\ & + \delta_6 Revenue\ Scale\ Efficiency_{it} + \xi' X_{ist} + \omega_{ist} \end{aligned} \tag{2}$$

where i refers to insurer i, s refers to state s, and t is time t. X_{ist} is a vector of control variables for insurer i in market s at time t, and ε_{ist} and ω_{ist} are error terms for insurer i in market s at time t. The coefficients on key explanatory variables (i.e., $\beta(\delta)_1$, $\beta(\delta)_2$, $\beta(\delta)_3$, $\beta(\delta)_4$, $\beta(\delta)_5$, and $\beta(\delta)_6$) are used to evaluate the SCP, RMP, ESX, and ESS hypotheses. Details of the model are discussed more fully below.

The Structure-Conduct-Performance Hypothesis. Under the SCP hypothesis, a positive association between concentration and performance is expected (Stigler, 1964). In a highly concentrated market, collusive behavior is hypothesized to be more likely to

[5] Although this is the first study to include revenue efficiency in the price and profit models, it is not the first study to estimate both cost and revenue efficiency. Other examples include Berger et al. (2000), Vander-Vennet (2002), Cummins, Tennyson, and Weiss (1999), Hasan, Malkamaki, and Schmiedel (2003), Orea (2002), and Cummins and Nini (2002).

occur, since only a relatively small number of firms must agree to collude. Thus, positive signs on β_1 and δ_1 in Equations (1) and (2) would be consistent with the SCP hypothesis. Furthermore, if only the SCP hypothesis holds, the market share variable should have a negligible impact on profit and price, and efficiency effects should be smaller than if only the ESX and ESS hypotheses alone are tested.

The Relative-Market-Power Hypothesis. If concentration and efficiency are controlled for, the RMP hypothesis suggests that market share should reflect market power (see Rhoades, 1985; Shepherd, 1986; Berger and Hannan, 1993; Berger, 1995). Thus, under RMP, market share is the key variable, and positive coefficients for market share in Equations (1) and (2) would provide support for this hypothesis. The positive performance-market share relationship arises, it is hypothesized, because firms are able to increase prices as their market power (measured by market share) increases. Increased prices should be reflected in higher profits, so positive signs on the market share variables are expected under the RMP hypothesis. In addition, if *only* RMP holds, the coefficient for concentration should be insignificant, and the efficiency variables should be relatively unimportant.

The X-Efficiency Hypothesis. Under ESX, X-efficiency is the driving force for profit and price after controlling for the effect of other variables. It is hypothesized that superior firms set lower prices than other firms because they operate with lower costs. Also efficient firms (those with high cost X-efficiency) would be able to earn higher returns than competitors. Revenue X-efficiency is derived from such activities as cross-selling and may rely heavily on the use of detailed information from customer databases to identify potential customers. The concept of revenue X-efficiencies are incorporated in the "financial supermarket" concept and development of a "brand name" to attract customers. Revenue X-efficiencies may raise privacy issues, to the extent they are related to the sharing of financial and other information about potential customers. (Privacy is an important but unresolved issue in financial services consolidation under the Gramm-Leach-Bliley Act of 1999.) Thus, the impact of revenue X-efficiency on prices and profits may be an important component of market structure and conduct.

Positive signs for β_3 and β_5 in Equation (1) and a negative coefficient for δ_3 in Equation (2) would be consistent with the ESX hypothesis. The profits of superior firms result from costs that are lower than inefficient firms, and thus, prices charged by superior firms are more favorable to consumers. On the other hand, revenue X-efficient firms may charge higher prices than less X-revenue efficient firms. That is, customers may be willing to pay more for the "one-stop-shopping" advantage associated with revenue X-efficiency (e.g., because of savings in search costs). Thus, the expected sign for δ_5 in Equation (2) cannot be predicted. Finally, if the ESX hypotheses are supported, the coefficients for the market structure variables (i.e., concentration and market share) should be zero.

The Scale Efficiency Hypothesis. Scale efficiency is the key exogenous variable under the ESS hypothesis. It is hypothesized that firms may have lower unit costs and higher unit profits simply because they operate at optimal scale. Thus, firms with similar technology and comparably skilled management may operate at different levels of scale efficiency. In fact, exploiting cost scale economies is often given as a reason for consolidation in the financial services industry. For example, recent improvements in information technology (IT) are expensive, and a larger base over which to spread these expenses is desirable. Also, revenue scale-efficiency indicates whether an insurer is generating enough total revenue given the inputs available (e.g., whether insurers are fully exploiting the large databases made possible by IT improvements). Revenue scale economies would exist if some customers prefer to buy products from large institutions or require specialized services (e.g., because they have large or unusual risks). Revenue scale economies may be derived from better diversification of risk among larger institutions (i.e., better risk pooling).

If scale efficiency is the main force driving insurers' performance, positive coefficients for β_4 and β_6 and a negative coefficient for δ_4 are expected in Equations (1) and (2), respectively. The coefficient for the revenue scale-efficiency variable is difficult to predict in the price equation. If insurers use some of the cost savings from cost scale-efficiency to provide better services, this would show up in higher prices and higher revenue scale-efficiency (Berger, 2000). On the other hand, if customers prefer more personalized service from smaller insurers, then revenue scale diseconomies may occur (Berger, 2000). Finally, Berger and Hannan (1993) argue that no relationship between market structure and price or profit should exist (i.e., $\beta(\delta)_1 = \beta(\delta)_2 = \beta(0)$), after controlling for efficiency under the ES hypotheses.

Comparison with Previous Insurance Studies

The ES hypothesis states that firms that are more efficient will grow in size and market share because they are able to charge lower prices than competitors while maintaining profitability. Thus, companies that are more efficient are expected to grow in size regardless of the number or mix of lines that they write. Higher profitability will usually lead to higher market concentration. So, concentration levels should increase under ES. In fact, overall concentration levels have increased significantly in the property-liability insurance industry during the 1990s. For example, the four-firm concentration level with respect to assets increased by 7.5 percent from 1993-2000.[6]

Efficiency arises from superior management and may be manifested *company-wide* in a number of ways as discussed in the previous section. Company-wide efficiency may be related to producing an optimal output mix (e.g., benefiting from economies of scope); so, as firms become more efficient, they may increase or decrease writings in specific lines of insurance to attain economies of scope. Similarly, efficiency may be related to diversification across lines of business to reduce risk and capital costs. (Note that capital input or surplus is not divisible by line.) So, again, improvements in efficiency may affect growth in some lines at the expense of others. Application of improved technology (such as IT advancements) would be expected to reduce costs across all lines. Revenue efficiency may arise from sharing the reputation that is associated with a brand name, and it is associated with cross-selling different lines of business. So, revenue efficiency is affected by the entire portfolio of insurance lines written by the firm; thus, it is expected to affect company-wide performance.

[6] More generally, the four-firm, eight-firm, and twenty-firm concentration levels with respect to assets and premiums have increased over the period 1993-2000 (Cummins and Xie, 2004).

The above suggests that market data aggregated to the company level can be used in testing the ES hypotheses because efficient firms *as a whole* are expected to grow, with corresponding increases in market share and concentration. Also, using company-wide profits and prices eliminates the effect of any cross-subsidization across lines of business (e.g., in response to price regulation).[7] These are probably reasons previous market structure banking studies use company-wide prices and profits in their models.

Previous insurance market structure studies, however, frequently focus on results by line of business and by state.[8] The reason for this is that concentration and market shares can vary substantially within a state by individual line of business (Cummins and Weiss, 1992; Suponcic and Tennyson, 1998). So, statewide market shares and concentration levels may appear to be competitive even though only a small number of insurers in the state write particular types of coverage (such as workers compensation or medical malpractice). Another reason for focusing on a specific line is that consumer buying occurs locally, and competition in local markets (rather than the national level) is more important for some lines of insurance, such as automobile insurance (Bajtelsmit and Bouzouita, 1998). Hence the results of this study may not be directly comparable with previous insurance research.

However, there are some caveats in using performance measures that vary by line to examine the ES hypothesis. It would not necessarily be true that higher efficiency leads to higher market concentration in a specific line if economies of scope or diversification of risk (by writing a mix of different lines) are significantly related to efficiency improvement. That is, using line level performance data can cause a problem in testing a hypothesis that states efficient firms should be growing (ES) if improvements in efficiency require writing less business in some lines. And as mentioned earlier, company activity like cross-subsidization across lines of business may influence the analysis. The problem of allocating expenses and investment income to determine profit and prices by line must be dealt with too. Carroll (1993, pp. 192, 205) notes that it is not easy to allocate some expenses and investment income by line of insurance and difficulties with this may affect the results of her analysis. The only way to deal with these problems is to use company-wide prices and profits in the analysis.

Thus, tradeoffs exist in determining the role of efficiency in property-liability insurance market structure. To gauge the role of efficiency in *overall* industry consolidation among multiline insurers (which is certainly occurring at the present time), it makes the most sense to focus on company-wide analysis (using company wide market share and concentration by state). Even if state market structures vary by line, efficient firms should still grow through charging lower prices while maintaining profitability. The

[7] Like insurers, banks produce a wide range of products ranging from personal (savings and loans) to commercial business (e.g., investment banking). A large segment of economic literature in the banking industry deals with managing an array of banking services. Also, Goldberg and Rai (1996) study structure-conduct-performance internationally among large banks in Europe and several other countries. The banks in this study were very diverse.

[8] An exception to this is Chidambaran, Pugel, and Saunders (1997).

end result will be higher concentration under this hypothesis. The company-wide state market shares and concentration variables will reflect primarily the state market structure for the highest volume lines in the state. Investigation of line-specific affordability and availability issues, on the other hand, may need to take into account line-level market structure data in spite of the potential cross-subsidization and expense allocation problems. Affordability and availability issues frequently arise in conjunction with line-specific state regulation, which most likely interacts with market structure. Also, line-level analysis using line-level market share and concentration data may be most appropriate for relatively small volume lines (e.g., medical malpractice) since many insurers do not write these lines. Note that the models described here can be adapted to a by-line analysis by using line data on price, profits, market shares, and concentration.

METHODOLOGY

In this section, the econometric considerations in estimating Equations (1) and (2) are discussed, including the possible endogeneity of some equation variables. Following this, the dependent and independent variables included in Equations (1) and (2) are discussed. The techniques to estimate the efficiency variables are described in their own subsection.

Econometric Considerations

SCP relationships are hypothesized to be simultaneous cause-and-effect relationships between market structure, firm conduct, and firm performance (see Clarke and Davies, 1982; Jung 1987; Carroll, 1993). Therefore, simultaneous equation bias may exist in using regression analysis to estimate Equations (1) and (2). Tests are conducted to determine whether endogeneity exists with respect to the market share and concentration variables in the price and profit models (Equations (1) and (2)). Augmented Durbin-Wu-Hausman (DWH) tests are conducted for all models to determine whether the suspect variables are endogenous (see Davidson and MacKinnon, 1993, pp. 237-242).[9] The efficiency variables used in the analysis are predicted variables from a stochastic frontier, hence they are measured subject to error. Therefore, instruments for the efficiency variables are used in all models as well as for any other endogenous variables (Pagan, 1984; Greene, 2000).

Analysis of residuals is conducted for all equations to determine whether heteroscedasticity exists. Generalized method of moments (GMM) is used to estimate all heteroskedastic equations containing no endogenous variables. Otherwise, heteroskedastic two-stage least squares (H2SLS) is used (Davidson and MacKinnon, 1993). Weighted least squares (WLSs) are also estimated for some models as a robustness check.

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[9] That is, the cause-effect relationship is assumed to occur in moving from the market structure variables (concentration and market share) to the performance indicators (insurance profitability and price) in Equations (1) and (2). On the other hand, the market structure might depend upon the performance of firms in the market. For example, firms with high profits may increase their market share, and market concentration will increase as a result. So, in either case, structure and performance are simultaneously determined.

Specification of Regression Variables

In this subsection, considerations in estimating the dependent and independent variables from Equations (1) and (2) are discussed.

Dependent Variables. Profit can be expressed as a function of two components, price and cost. Price reflects the effect of any collusive behavior, while cost-differentials reflect a firm's efficiency.[10] This study employs two measures of insurer performance, profitability and price, as dependent variables. An analysis of both profit and price as a function of market structure and efficiency provides for a more complete picture of the relationship between market structure and performance.

A form of the underwriting profit margin is used to gauge an insurer's profitability. The profit margin used is

$$1 - \frac{PV\ of\ Losses\ Incurred}{Premiums\ Earned} - \frac{Expenses}{Premiums\ Written},$$

where *PV* denotes present value. (Losses incurred includes loss adjustment expenses.) The present value of losses incurred divided by premiums earned is also called the economic loss ratio. Discounting incurred losses allows for a more meaningful measure of profitability than reported (nondiscounted) losses incurred, since losses are estimated in the same way in the numerator and denominator of the economic loss ratio (i.e., using present values). So, losses should be discounted when comparisons to premiums are desired.

Price is estimated as premiums earned divided by the present value of losses incurred (i.e., the inverse of the economic loss ratio). (See Winter, 1994; Cummins and Danzon, 1997, for further discussion and use of this price variable.)

Market Structure Variables. Consistent with many industrial organization studies, the Herfindahl index is used to measure market concentration in a state in which each insurer operates.[11] The Herfindahl index for each state is defined as the sum of the squared market share for direct premiums written of each insurer in the state. Market share is defined as the proportion of total premiums accounted for by insurer i in state s at time t, and is computed based on direct premiums written.

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[10] The price-concentration relationship is advocated over profit-concentration analysis in several studies. Weiss (1989) argues that tests of price-concentration provide an improvement over profit analysis for evaluating an efficiency-related hypothesis. Jackson (1992) also argues that using price as an indicator of performance is superior to profit analysis.

[11] Stigler (1964) argues that the Herfindahl index is superior to the concentration ratio (e.g., four-firm concentration ratio) for measuring concentration to assess the likelihood of effective collusion. A theoretical link between the price-cost margin and the Herfindahl index is well documented (see Cowling and Waterson, 1976; Clarke and Davies, 1982; Clarke, Davies, and Waterson, 1984; Hay and Liu, 1997).

Other Control Variables. In addition to the key exogenous variables used to test specific hypotheses, other factors might influence market prices and profit. Control variables used in this study include market growth, advertising-intensity, reinsurance utilization, mix of business, distribution system, regulatory system, stock ownership form, and group status.

Reinsurance may affect the overall riskiness of the insurer. Expanding capacity, stabilization of loss experience, and catastrophe protection are usually considered main functions of reinsurance. Thus, reinsurance transactions are related to underwriting risk and capacity, and affect ceding insurers' performance and conduct. Reinsurance ceded (reinsurance assumed) defined as the ratio of the sum of reinsurance ceded (assumed) to direct premiums written is included in the profit and price equations. The signs of these variables are uncertain. Reinsurance activities may increase cost, leading to higher prices and/or lower profit. On the other hand, if reinsurance significantly improves diversification of risk among the policyholder pool, reinsurance activities may reduce price and profit (because of lower net pooling risk).

The lines of business an insurer writes can affect the overall risk of the insurer. Also, market structure and performance can be affected by the lines of business mix because of differences in marketing, demand, and complexity of underwriting processes. Therefore, the proportion of total premiums written in personal lines is included as an explanatory variable.

Insurance is distributed to customers in a number of different ways, and different distribution systems vary according to costs and barriers to entry considerations. Some insurers use independent agents or brokers to distribute insurance, especially in complex lines of insurance such as commercial liability. The alternative is direct writing. Direct writers rely relatively more on factors such as advertising and (computer) automation in distributing insurance. Also, dominance of a market by direct writers is considered to be a barrier to entry (Regan, 1999; Regan and Tennyson, 2000). Therefore, advertising-intensity is included as a control variable in the model, and it is defined as the ratio of advertising expenses divided by net premiums written. The independent agency system has been shown to have higher cost than direct writing in insurance studies (e.g., Berger, Cummins, and Weiss, 1997, among others); hence another distribution system variable, agent, defined as a dummy variable equal to one if the independent agency system is used and zero otherwise, is included in the model.

Market growth may entice other insurers to enter a state market, possibly depressing profitability; on the other hand, if significant barriers to entry exist, then growth in the state market may lead to increased profitability among a state's insurers. In addition, growth allows firms to expand with less intense price competition than in a slow growth market. Therefore, growth of direct premiums written (DPW) in the state is used as a control variable. Growth is defined as $[(DPW)_{s,t} - (DPW)_{s,t-1}]/(DPW)_{s,t-1}$.

Three dummy variables are used to control for ownership, group affiliation, and regulation. Regulation is a dummy variable equal to one if the state is rate regulated and zero otherwise.[12] The regulation variable is interacted with the mix of business variable in case regulation has a differential effect on insurers writing different mixes of business. Stock Ownership is a dummy variable that has the value one if a sample insurer is a stock company and zero otherwise. Lastly, group indicates whether a company is a member of a group, with a value of one denoting membership in a group; otherwise the value of this variable is zero.

Table 1 summarizes the variables used in the study. Expected coefficient signs and rationales for including the variables are presented as well.

Efficiency Estimation

In this research, efficiency is estimated econometrically using an SFA. Cost and revenue efficiencies are estimated, although for illustrative purposes the discussion below focuses on estimating cost efficiency.

Using SFA, the log of the cost function is typically specified as

$$\ln C_i = \ln \hat{C}(Y_m, P_j) + \varepsilon_{ic}$$

where C_i are costs of insurer i, Y_m is a vector of outputs, P_j is the input price vector, and ε_{ic} is an error term that captures random deviations from the cost frontier as well as inefficiency. That is, ε_{ic} is specified as, $\varepsilon_{ic} = \phi_{ic} + \nu_{ic}$. The first term ($\phi_{ic}$) reflects random deviations from the frontier and is usually assumed to be normally distributed, with a mean of zero. The second term (ν_{ic}) reflects X-inefficiency. Note that X-inefficiency can only increase costs, so inefficiency is defined in terms of how far the firm operates above the cost frontier. The inefficiency term ν_{ic} is usually assumed to follow a half normal or truncated normal distribution, and the truncated normal distribution is adopted in this study.

To estimate inefficiency, the function $\ln\hat{C}_i$ is estimated econometrically, and the residual is calculated:

$$\ln C_i - \ln \hat{C}_i = \hat{\varepsilon}_{ic}.$$

Breaking down $\hat{\varepsilon}_{ic}$ into its two components involves finding the conditional probability distribution of v_{ic} given $\hat{\varepsilon}_{ic}$. Then ν_{ic} is estimated as the conditional expectation $E(\exp(-\nu_{ic} \mid \varepsilon_{ic}))$ (Greene, 1993). The cost-efficiency component of ε_{ic} is calculated as

$$Efficiency_i = E\left(C_i^* \mid \nu_{ic} = 0, G_i\right) / E\left(C_i^* \mid \nu_{ic}, G_i\right),$$

where G_i is a vector of input prices and output of the i^{th} firm and C_i^* is the cost of the i^{th} firm, which is equal to $exp(C_i)$ if the dependent variable is the logarithm of the

[12] The same definition of rate regulation is used as in Harrington (2002). States are considered rate regulated if a strict prior approval law exists, a prior approval law with an express "deemer" provision exists, a modified prior approval law with respect to changes in the relation of premiums and expenses exists, state made rates are used or a file and use law is in place that requires prior approval for deviations from the rates developed by the rate advisory organization. For more details, see Harrington (2002, p. 290, 314).

TABLE 1
Description of Variables

Variable	Definition	Expected Sign: *Profit*	Expected Sign: *Price*	Reason
Dependent variable				
Profit	1–economic loss ratio–expense ratio			Measure of profitability
Price	Ratio of premiums earned to the present value of losses incurred			Measure of insurance price
Independent variables				
Concentration	The Herfindahl index = sum of the squared market shares in the state	+	+	To test the SCP hypothesis
Market share	Ratio of insurer's prem. written in state to total premiums in the state	+	+	To test the RMP hypothesis
Cost X-efficiency	Cost X-efficiency score	+	−	To test the ESX hypothesis
Revenue X-efficiency	Revenue X-efficiency score	+	?	To test the ESX hypothesis
Cost scale-efficiency	Cost scale-efficiency score	+	−	To test the ESS hypothesis
Revenue scale-efficiency	Revenue scale-efficiency score	+	?	To test the ESS hypothesis
Control variables				
Market growth	Growth in market premiums = $(DPW)_{s,t} - (DPW)_{s,t-1}/(DPW)_{s,t-1}$	?	?	To control for differences across markets
Advertising intensity	Ratio of advertising expenses to net premiums written	+	+	To control for barriers to entry

(*continued*)

TABLE 1
(Continued)

Variable	Definition	Expected Sign		Reason
		Profit	*Price*	
Reinsurance ceded	Ratio of reinsurance ceded to direct premiums written	+	+	To control for supply of insurance
Reinsurance assumed	Ratio of reinsurance assumed to direct premiums written	−	−	To control for supply of insurance
Mix of business	Proportion of premiums written in personal lines	?	?	To control for risk and demand factors
Independent agent dummy	Dummy variable equal to 1 if independent agency used	?	+	To control for differences in distribution systems
Regulation dummy	Dummy variable, equal to 1 if the state is regulated	?	?	To control for pricing and barriers to entry
Stock ownership dummy	Dummy variable, equal to 1 if an insurer is a stock company	+	?	To control for risk and supply factors
Group dummy	Dummy variable, equal to 1 if an insurer is a member of group	?	?	To control for risk and supply factors
Regulation × mix of business	Interaction term	?	?	To control for regulation by business mix

cost of production (see Coelli, 1996). Cost X-efficiency varies from zero to one, with one signifying 100 percent efficiency. It is defined as minimum attainable costs (given output and existing technology) divided by actual costs.

Finally, a functional form is needed to estimate *ln* C_i, and a flexible functional form, the translog, typically is used:

$$\ln C_i = \alpha_0 + \sum_{i=1}^{n} \beta_i \ln(y_i) + \sum_{j=1}^{m} \gamma_j \ln(p_j) + \frac{1}{2}\sum_{i=1}^{n}\sum_{k=1}^{n} \beta_{ik} \ln(y_i)\ln(y_k) + \frac{1}{2}\sum_{j=1}^{m}\sum_{h=1}^{m} \gamma_{jh} \ln(p_j)\ln(p_h) + \sum_{i=1}^{n}\sum_{j=1}^{m} \delta_{ij} \ln(y_i)\ln(p_j) + \varepsilon_i. \tag{7}$$

The parameters of the cost function are used to estimate scale inefficiency:

$$\text{SCALE}_{ic} = \sum_{\text{i}=1}^{n} \frac{\partial \ln(C)}{\partial \ln(\text{y}_\text{i})} = \sum_{i=1}^{n} \left[\beta_i + \frac{1}{2}\sum_{k=1}^{n} \beta_{ik} \ln(y_k) + \sum_{j=1}^{m} \delta_{ij} \ln(p_j)\right]. \tag{8}$$

Cost scale-efficiency is measured for each insurer at its respective output level. If SCALE_{ic} is less than one, then increasing returns to scale exists. Otherwise, if SCALE_{ic} is greater than one, decreasing returns to scale are indicated. Firms operating at constant returns to scale ($\text{SCALE}_{ic} = 1$) are considered to be scale efficient.

To estimate revenue X-inefficiency and revenue scale inefficiency, a revenue function is specified:

$$\ln R_i = \ln \hat{R}(P_m, X_j) + \varepsilon_{iR},$$

where R_i are revenues of insurer i, P_m is an output price vector, X_j is an input vector, and ε_{iR} is an error term. As with the cost function, the error term is assumed to consist of two components, $\varepsilon_{iR} = N_{iR} - \nu_{iR}$. Note that in this case, the inefficiency term ν_{iR} is subtracted, since revenue inefficiency can only reduce revenues. Otherwise, the same procedures are used to estimate revenue X-inefficiency and revenue scale inefficiency as for cost.

Like cost efficiency, revenue efficiency scores vary from zero to one, with one signifying 100 percent efficiency. The efficiency score can be interpreted as the ratio of actual revenue to maximum possible revenue given output prices and input levels.

Costs are defined as the sum of total expenses (net of loss adjustment expenses) and the cost of capital. (The cost of capital estimation is discussed below.) Revenues include premiums earned minus the present value of losses plus investment income. In the remainder of this section, measurement of output and input prices and quantities are discussed, as these are needed to estimate the cost and revenue functions. The measures used here are the same as in the existing literature, hence the discussion will be brief. More details are available in Berger, Cummins, and Weiss (1997), Cummins, Weiss, and Zi (1999), and Cummins and Weiss (2000), among others.

A value-added approach is used to estimate output (Berger and Humphrey, 1992; Cummins and Weiss, 2000). In this approach, important financial statement items are considered to have some characteristics of outputs and inputs. Items associated with a significant value added are deemed outputs. Since insurers' output consists of services (which are intangible), tangible proxies are used to measure them. Insurers' services consist primarily of risk pooling and risk bearing, intermediation, and "real" financial services (such as loss adjustment). The most commonly recognized output proxies are losses incurred (proxying for risk bearing and pooling and real financial services) and invested assets (proxying for intermediation). Some services vary by line; therefore, a distinction among lines is made. Lines of insurance can be broadly classified as: (i) short-tail personal lines such as auto physical damage; (ii) long-tail personal lines such as auto liability; (iii) short-tail commercial lines such as fire; and (iv) long-tail commercial lines such as general liability. In this study, the present values of losses incurred are used as output measures, and a distinction among the four "lines" of coverage (described above) is made. Each output measure is deflated by the Consumers Price Index (CPI) to make quantities comparable across different years.[13]

Output prices are needed also to estimate revenue inefficiency. The output price for each line of insurance under the value-added approach is estimated as the difference between premiums earned and the present value of losses incurred, expressed as a ratio to the present value of losses incurred:

$$(Output\ price)_{ikt} = [Premium_{ikt} - PV(L)_{ikt}]/PV(L)_{ikt},$$

where *Premium* denotes premiums earned, *PV(L)* indicates present value of losses and loss adjustment expenses, and the subscripts i, k, and t refer to insurer i, output k and time t, respectively. The price for intermediary services is the sum of the expected return on equities and realized rate of return for all invested assets (net of equity).

Insurers use four primary inputs: agents' services, (nonagent) labor services, materials (such as postage, travel, communications, etc.), and equity capital. The quantity of agent, labor, and materials input is measured as the constant dollar value of these inputs. That is, the actual expenses for these items are divided by price deflators to find the constant dollar values. The price for these inputs is measured as the current dollar value of these expenses divided by the constant dollar value. These input measures have been used extensively in other insurance studies.[14]

Equity capital is measured as the sum of policyholders' surplus and the redundant statutory liabilities: excess of statutory over statement reserves, and unauthorized reinsurance.[15] Equity capital is deflated by the CPI to allow comparisons among years. Expected rather than actual return to capital (or net income) is needed to measure the cost of equity capital. Therefore, cost of equity capital is estimated from a regression

[13] The Consumers Price Index—All Items is used.

[14] For a more extensive discussion of this input measurement methodology, see Weiss (1991) and Cummins and Weiss (2000), among others.

[15] In addition, an adjustment for equity in the unearned premium reserve is added to equity. Insurer equity is increased by prepaid acquisition expenses incorporated in the unearned premium reserve.

equation with actual return to equity capital as the dependent variable and independent variables reflecting the lines of business mix and other characteristics of the insurer.[16] A list of all of the variables needed to estimate efficiency are contained in Appendix 1.

SAMPLE SELECTION AND DATA

The potential sample of insurers consists of all property-liability insurers that report data to the NAIC in an annual statement for the period 1992–1998. From this potential sample, insurers with negative surplus, assets or premiums were deleted. Also, insurers with negative inputs or outputs (for the efficiency analysis) were deleted. As in the prior banking studies, firms with a minimum market share were deleted, because small companies are not likely to have a significant impact on price and supply in the state market. Thus, insurers with less than a 0.1 percent share of total state premiums were discarded. Cross-sectional, time series data for the period 1992–1998 are pooled in the models; but the data are not panel data. We allow insurers to enter and exit different state markets (as state market conditions change) over the sample period.

The data used here are at the company level. Market structure varies by state, so, use of data by state provides the opportunity to view how the same insurer operates across different (state) market structures. Company rather than group data are more appropriate to use in the analysis since it is the company (rather than the group) that is overseen by state regulators. For example, it is the company that is licensed to operate in a state, not the group. It is assumed also that competition exists among insurers at the state level. However, because it might be argued that market power is wielded by the group, the robustness of the main model is determined by estimating the model with both group- and company-level data.

Data for $price_{ist}$ and $profit_{ist}$ were obtained from each insurers' annual statement. To find $profit_{ist}$, expenses by state are needed. Exhibits in the annual statement contain an allocation for commissions and brokerage expenses and an allocation for taxes, licenses, and fees by state.[17] Therefore, the remaining underwriting expenses (i.e., total expenses minus the latter two items) must be allocated by state to determine profit by state for each insurer. These expenses are allocated to each state on the basis of direct premiums written. Direct premiums rather than net premiums are used for the allocation because data for net premiums by state are unavailable.[18]

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[16] The insurers' actual returns on equity were regressed on the following variables: proportion of invested assets in stock; proportion of invested assets in bonds; proportion of invested assets (to total assets); proportion of output in major output lines; leverage; variance of the company-wide loss ratio (including correlations among lines of business); and year dummy variables. Initial analysis indicated that heteroskedasticity was present in the model. Therefore, weighted least squares (WLS) was used in estimation with the weight equal to current assets. Then, the predicted values from this estimation were used as estimates for the cost of capital in the efficiency analysis.

[17] The data were obtained from The Exhibit of Premiums and Losses (i.e., statutory page 14 data).

[18] If expenses actually vary by net premiums written and the net premiums written are significantly different from direct premiums, then the estimate of profit may be affected. That is, direct premiums exclude reinsurance assumed and are gross of reinsurance ceded. So,

To find $price_{ist}$ and several output measures (used in the efficiency analysis), the present value of losses incurred must be estimated. Thus, a payout pattern must be estimated for losses, and then a discount rate selected to discount losses back to the present. Data to estimate payout patterns for losses are obtained from analysis of Schedule P for the property-liability insurance industry (*Best's Aggregates & Averages*).[19] Discount rates used are based on U.S. treasury yield curves and are obtained from the *Federal Reserve Bulletin* (Board of Governors of the Federal Reserve System) and *Stocks Bonds Bills and Inflation* (*SBBI*) (Ibbotson Associates, Chicago). The procedure used to estimate discounted losses in this study is the same as in prior research (e.g., see Cummins and Weiss, 2000).

Data for reinsurance ceded and assumed, equity capital, net income, advertising expense, business mix, ownership, and group status were obtained from the Annual Statement. Data for the agent dummy were obtained from *Best's Key Rating Guide* (A.M. Best Co.).[20] Current dollar materials input consists of items reported in the expense exhibit in the annual statement, net of labor and agents-related expenses and loss adjustment expenses. Current dollar labor input is measured using expenses for salaries, employee benefits, and social security taxes paid by the employer. Current dollar agents and brokers inputs are obtained from rows 2 and 3 of the expense exhibit in the annual statement.

The deflator for labor is derived from estimated average weekly wages by state for Standard Industrial Classification (SIC) 6331—Fire, Marine, and Casualty Insurers. Each insurer's labor expense deflator is based on average weekly wages in the state that the insurer's home office is located. The agents and brokers deflator is derived from estimated average weekly wages by state for SIC 6411— Insurance Agents and Brokers. To find the agents and brokers deflator for each insurer, a weighted average is taken of each state's agent wage deflator, with the weight equal to the proportion of premiums written in that state by the insurer. The SIC information used to estimate the labor and agent deflators are available from the U.S. Department of Labor. The deflator for materials input is the Gross Domestic Product (GDP) deflator for business services, and it is available from the U.S. Department of Commerce. All of the techniques and data sources used for computing output and input quantities and prices are consistent with recent past efficiency studies (e.g., Berger, Cummins, and Weiss, 1997; Cummins, Weiss, and Zi, 1999; Cummins and Weiss, 2000).

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if underwriting expenses vary by reinsurance assumed and/or reinsurance ceded, then, the estimate of profit might be affected. Specifically, it might look like profit is decreasing (increasing) as reinsurance assumed (ceded) increases. The addition of explanatory variables for reinsurance assumed and ceded can be used to control for this possible problem.

[19] Specifically, the chain ladder method with inflation adjustment is used for each line reported in schedule P to obtain line-specific payout proportions. For details of the chain ladder method, see Hossack, Pollard, and Zehnwirth (2001).

[20] For the group analysis, the distribution system and ownership dummies reflect the information of the lead company of the group. The lead company of the group is determined on the basis of premiums written. Thus, if the lead company is classified as using the agency system, the agency dummy variable takes the value of one, and zero otherwise. The other explanatory variables (i.e., variables based on ratios) are determined by aggregating together the data for individual companies in the group and then computing the ratio.

TABLE 2
Summary Statistics for Variables Used in Regressions Sample Period: 1992–1998

	Company		Group	
Variable	Mean	Standard Deviation	Mean	Standard Deviation
Profit margin	0.022	0.419	0.023	0.341
Price	1.631	0.835	1.692	0.880
Concentration (Herfindahl index)	0.026	0.008	0.046	0.011
Market share	0.007	0.014	0.010	0.020
Cost X-efficiency	0.802	0.056	0.794	0.057
Cost scale-efficiency	0.856	0.102	0.852	0.102
Revenue X-efficiency	0.729	0.123	0.734	0.110
Revenue scale-efficiency	0.918	0.073	0.916	0.070
Market growth	0.038	0.042	0.038	0.042
Advertising intensity (advertising expenses/NPW)	0.003	0.008	0.003	0.009
Reinsurance ceded proportion	0.521	0.723	0.475	0.517
Reinsurance assumed proportion	0.593	1.090	0.537	0.770
Mix of business (proportion personal lines)	0.392	0.396	0.401	0.382
Independent agency dummy (=1 if independent agency)	0.754	0.431	0.720	0.449
Regulation dummy (=1 if regulated state)	0.620	0.485	0.622	0.485
Stock ownership dummy (=1 if stock insurer)	0.769	0.421	0.753	0.432
Group dummy (=1 if group member)	0.938	0.241	0.906	0.292
Regulation × mix of business	0.241	0.363	0.250	0.360
Premiums written (thousands)	\$35,259	\$106,601	\$55,033	\$160,608
Observations	33,440		20,836	

RESULTS

Summary statistics for variables used in the profit and price equations are presented in Table 2. The final sample accounts for approximately 68 percent of total property-liability premiums written in the U.S. Summary statistics for the variables used to estimate efficiencies are shown in Appendix 1. Details of the sample data (i.e., number of insurers by year and state) are provided in Appendix 3. Tables 3 and 4 report results from the price and profit equations (Equations 1 and 2). Tables 5 and 6 present results for Equations (1) and (2) when the market share and concentration variables are eliminated from the analysis and alternatively when the efficiency variables are omitted from the analysis. Table 7 reports the results for Equations (1) and (2) by year. The remainder of this section discusses all of these results.

Tests for endogeneity for Equations (1) and (2) indicated that the concentration and market share variables were not endogenous in the price and profit equations when company data are used. For the group data, market share was endogenous in the price and profit equations. Instrumental variables were used in all cases in which market share and/or concentration were found to be endogenous. As explained in the Methodology section, instrumental variables were used for all of the efficiency-related variables in Equations (1) and (2).[21]

Further testing indicated that heteroskedasticity was present in some models estimated in Tables 3 through 7. H2SLS can be used when some regressors are endogenous; hence, H2SLS is used to estimate some of the models reported in Tables 3 and 5.[22] For comparison purposes, two-stage WLSs estimates were obtained as well; the latter results are presented in Tables 4, 6, and 7.[23]

Results of Price and Profit Regressions From Equations 1 and 2

To streamline discussion of the results, the discussion of the profit and price regressions focuses on the company and group results in Table 3 (i.e., GMM and H2SLS). The results for WLS in Table 4 are briefly discussed after Table 3. WLSs are estimated as a robustness test for the results in Table 3.

Price is positively related to concentration, and profit is positively related to concentration as well in all models in Table 3. These relationships are significant at the 10 percent level or better, except for the group models in Table 3. The positive signs for the concentration variable support the SCP hypothesis. The coefficient for market share is negatively related to price and significant in the company model in Table 3, while market share is positively related to profit in all other models and significant in the group profit model. The negative and/or insignificant signs for the market share variables do not support the RMP hypothesis, since a positive and significant coefficient for the market share variable is expected under this hypothesis. Hence, only the positive and significant sign for the market share variable in the group profit model supports the RMP hypothesis.

In Table 3, cost X-efficiency and cost scale-efficiency are negative and significant in both price models. These results support the ES hypothesis. On the other hand, revenue X-efficiency and revenue scale-efficiency are positively related to price in all models and significant in all models. Recall that the expected signs for the revenue efficiency variables were indeterminate. The results can be interpreted as meaning that more revenue efficient firms charge higher prices, ceteris paribus.

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[21] The set of instrumental variables consists of all exogenous variables; the ranks of efficiency scores for cost X-efficiency, cost scale-efficiency, revenue X-efficiency, and revenue scale-efficiency; year dummies for 1993–1998; the interaction variables business mix $\times$ regulation, ownership $\times$ advertising activity, and market growth $\times$ ownership; and the logarithm of assets.

[22] Outliers were detected in the initial results and deleted from the final analysis. Outliers are defined as observations with a studentized residual (SDR) of greater than $|4|$. Outliers accounted for about 5 percent of the sample.

[23] Regression analysis of the squared error from OLS versions of Equations (1) and (2) indicated that the squared error was inversely related to assets. That means, for example, that prices and profit rates are more volatile for smaller companies than for larger ones.

TABLE 3
Profitability and Price Regressions for Company and Group Data, 1992–1998: Estimated by Generalized Method of Moments and Heteroskedastic Two-Stage Least Squares

	Company				Group			
Dependent Variable	Profit		Price		Profit		Price	
Independent Variables	Coeff.	*t*-Ratio	Coeff.	*t*-Ratio	Coeff.	*t*-Ratio	Coeff.	*t*-Ratio
Intercept	−0.2536	−0.33	0.7442	0.88	−1.1090	−4.71***	1.1087	1.28
Concentration	0.5138	1.74*	2.9621	4.35***	0.1179	0.53	0.5302	0.84
Market share	0.5831	1.42	−1.4808	−4.52***	2.9093	3.11***	1.0435	0.72
Cost X-efficiency	−1.4345	−1.36	−1.2628	−6.41***	0.0457	0.46	−2.1625	−9.66***
Cost scale-efficiency	0.6294	1.93*	−0.8591	−8.36***	0.5690	2.45**	−1.2654	−9.81***
Revenue X-efficiency	0.4907	3.77***	1.2001	4.90***	0.4362	7.38***	1.3476	4.13***
Revenue scale-efficiency	0.7027	2.51**	2.0758	2.11**	0.4091	1.90*	2.8348	3.00***
Market growth	−0.2833	−5.32***	−0.5255	−4.14***	−0.1529	−2.80***	−0.1786	−1.10
Advertising intensity	1.6406	4.83***	4.0162	5.61***	2.0737	5.44***	3.4367	4.49***
Reinsurance ceded	0.1960	21.33***	0.0907	4.68***	0.2206	21.03***	0.1108	5.47***
Reinsurance assumed	−0.3016	−45.70***	−0.1239	−11.71***	−0.2827	−29.48***	−0.1369	−10.31***
Mix of business	−0.1529	−6.06***	−0.3689	−15.38***	−0.1690	−5.50***	−0.3934	−9.76***
Regulation dummy	−0.0223	−3.23***	−0.0298	−1.77*	−0.0147	−2.03**	−0.0263	−1.21
Stock ownership dummy	0.0273	3.11***	0.0206	1.22	0.0318	4.87***	0.0129	0.56
Group dummy	0.0116	0.70	−0.0530	−1.11	−0.0279	−2.69***	−0.1079	−2.49**
Agent dummy	−0.0169	−0.66	0.0703	2.37**	0.0001	0.01	0.0344	0.97
Mix of business × regulation	0.0352	3.61***	0.0497	2.21**	0.0213	1.90*	0.0487	1.61
Adjusted R^2	0.264		0.040		0.203		0.039	
Observations	33,440		33,440		20,836		20,836	

***Significant at 1% level, **significant at 5% level, and *significant at 10% level.
Note: Company price model is estimated by GMM. H2SLS is used to estimate all other models. The efficiency variables are treated as endogenous in all models. Market share is treated as exogenous except in the group profit and price models, where it is treated as endogenous.

TABLE 4
Profitability and Profit Regressions for Company and Group Data, 1992–1998: Estimated by Two-Stage Weighted Least Squares

	Company				Group			
Dependent Variable	Profit		Price		Profit		Price	
Independent Variables	Coeff.	*t*-Ratio	Coeff.	*t*-Ratio	Coeff.	*t*-Ratio	Coeff.	*t*-Ratio
Intercept	−1.2495	−19.87***	4.1268	36.48***	−0.8219	−17.24***	3.3445	22.38***
Concentration	0.5916	2.05**	4.9251	6.65***	0.4635	2.25**	4.9424	7.65***
Market share	−0.9094	−1.52	−11.0249	−7.37***	−1.8875	−6.25***	−5.6085	−5.93***
Cost X-efficiency	0.8085	27.29***	−2.0357	−28.15***	0.4383	15.31***	−2.1268	−23.71***
Cost scale-efficiency	−0.2019	−7.12***	−1.5218	−24.08***	0.0829	3.06***	−1.5169	−17.86***
Revenue X-efficiency	0.3189	18.97***	0.3681	9.11***	0.4922	32.00***	1.0485	21.75***
Revenue scale-efficiency	0.5626	10.38***	0.3581	4.97***	0.0649	2.33**	0.2910	3.34***
Market growth	−0.0703	−1.92*	−0.5194	−5.58***	0.0933	2.69***	0.1733	1.60
Advertising intensity	2.1130	13.08***	1.1332	3.60***	−0.0428	−0.22	0.5494	0.90
Reinsurance ceded	0.1278	36.04***	0.0526	5.86***	0.0858	14.25***	0.0860	4.56***
Reinsurance assumed	−0.2589	−96.45***	−0.0908	−13.33***	−0.1857	−31.25***	−0.1760	−9.45***
Mix of business	−0.0736	−11.69***	−0.2382	−15.02***	−0.0053	−0.71	−0.2046	−8.75***
Regulation dummy	0.0010	0.20	0.0052	0.40	0.0667	12.43***	0.0390	2.32**
Stock ownership dummy	0.0544	14.09***	0.0675	6.86***	0.0135	4.28***	−0.0203	−2.04**
Group dummy	0.0066	1.55	−0.0259	−2.49**	−0.0111	−3.40***	−0.0422	−4.12***
Agent dummy	0.1649	12.84***	0.0133	1.20	0.0354	3.75***	0.3905	13.17***
Mix of business × regulation	0.0089	1.19	−0.0055	−0.28	−0.0607	−7.47***	−0.0271	−1.07
Adjusted R^2	0.236		0.120		0.130		0.129	
Observations	33,440		33,440		20,836		20,836	

***Significant at 1% level, **significant at 5% level, and *significant at 10% level.
Note: The efficiency variables are treated as endogenous in all models. Market share is treated as exogenous except in the group profit and price models, where it is treated as endogenous.

TABLE 5

Profitability and Price Regressions With and Without Controls for Efficiency, 1992–1998: Estimated by Generalized Method of Moments and Heteroskedastic Two-Stage Least Squares

	Company Data				W/O MS & CONC				W/O Efficiency Variables			
Dependent Variable	Profit		Price		Profit		Price		Profit		Price	
Independent Variables	Coeff.	*t*-Ratio	Coeff.	*t*-Ratio	Coeff.	*t*-Ratio	Coeff.	*t*-Ratio	Coeff.	*t*-Ratio	Coeff.	*t*-Ratio
Intercept	−0.2536	−0.33	0.7442	0.88	−0.2025	−0.25	0.8015	0.95	0.0659	5.7***	1.67061	50.14***
Concentration	0.5138	1.74*	2.9621	4.35***					0.7284	2.88***	3.21943	4.75***
Market share	0.5831	1.42	−1.4808	−4.52***					0.0928	0.93	−2.0432	−9.35***
Cost X-efficiency	−1.4345	−1.36	−1.2628	−6.41***	−1.4575	−1.35	−1.3034	−6.61***				
Cost scale-efficiency	0.6294	1.93*	−0.8591	−8.36***	0.6276	1.90*	−0.8646	−8.39***				
Revenue X-efficiency	0.4907	3.77***	1.2001	4.90***	0.4853	3.73***	1.1962	4.87***				
Revenue scale-efficiency	0.7027	2.51**	2.0758	2.11**	0.6933	2.45**	2.1219	2.16**				
Market growth	−0.2833	−5.32***	−0.5255	−4.14***	−0.2698	−5.04***	−0.4363	−3.52***	−0.2718	−5.82***	−0.5749	−4.57***
Advertising intensity	1.6406	4.83***	4.0162	5.61***	1.5563	4.39***	4.2347	5.94***	1.4308	7.33***	4.08289	4.68***
Reinsurance ceded	0.1960	21.33***	0.0907	4.68***	0.1959	21.25***	0.0920	4.74***	0.189	23.71***	0.06755	5.36***
Reinsurance assumed	−0.3016	−45.70***	−0.1239	−11.71***	−0.3017	−45.66***	−0.1242	−11.70***	−0.2953	−47.56***	−0.1097	−12.95***
Mix of business	−0.1529	−6.06***	−0.3689	−15.38***	−0.1489	−6.07***	−0.3749	−15.59***	−0.0894	−10.91***	−0.3913	−19.85***
Regulation dummy	−0.0223	−3.23***	−0.0298	−1.77*	−0.0220	−3.17***	−0.0267	−1.58	−0.0255	−4.2***	−0.0295	−1.79*
Stock ownership dummy	0.0273	3.11***	0.0206	1.22	0.0252	3.15***	0.0285	1.74*	0.0288	5.6***	0.0634	4.87***
Group dummy	0.0116	0.70	−0.0530	−1.11	0.0134	0.77	−0.0587	−1.23	0.0192	2.6***	0.0565	2.6***
Agent dummy	−0.0169	−0.66	0.0703	2.37**	−0.0211	−0.77	0.0763	2.68***	0.033	5.8***	0.0453	2.78***
Mix of business × regulation	0.0352	3.61***	0.0497	2.21**	0.0355	3.63***	0.0470	2.08**	0.0358	4.06***	0.0547	2.52**
Adjusted R^2	0.264		0.040		0.263		0.038		0.359		0.042	
Observations	33,440		33,440		33,440		33,440		33,440		33,440	

***Significant at 1% level, **significant at 5% level, and *significant at 10% level.

Note: H2SLS is used to estimate all profit models with efficiency-related variables, and the efficiency variables are treated as endogenous. GMM is used to estimate all other models.

TABLE 6
Price and Profitability Regressions With and Without Controls for Efficiency, 1992–1998: Estimated by Two-Stage Weighted Least Squares

	Company Data				W/O MS & CONC				W/O Efficiency Variables			
Dependent Variable	Profit		Price		Profit		Price		Profit		Price	
Independent Variables	Coeff.	*t*-Ratio	Coeff.	*t*-Ratio	Coeff.	*t*-Ratio	Coeff.	*t*-Ratio	Coeff.	*t*-Ratio	Coeff.	*t*-Ratio
Intercept	−1.2495	−19.87***	4.1268	36.48***	−1.2231	−19.82***	4.1421	36.78***	0.0652	4.67***	1.8121	69.36***
Concentration	0.5916	2.05**	4.9251	6.65***					−0.3788	−1.33	5.9609	7.80***
Market share	−0.9094	−1.52	−11.0249	−7.37***					0.2071	0.36	−18.3448	−11.94***
Cost X-efficiency	0.8085	27.29***	−2.0357	−28.15***	0.8051	27.25***	−2.0416	−28.00***				
Cost scale-efficiency	−0.2019	−7.12***	−1.5218	−24.08***	−0.2068	−7.43***	−1.5207	−24.12***				
Revenue X-efficiency	0.3189	18.97***	0.3681	9.11***	0.3187	19.05***	0.3746	9.18***				
Revenue scale-efficiency	0.5626	10.38***	0.3581	4.97***	0.5497	10.39***	0.3876	5.37***				
Market growth	−0.0703	−1.92*	−0.5194	−5.58***	−0.0540	−1.52	−0.3698	−4.09***	−0.1710	−4.73***	−0.5683	−5.89***
Advertising intensity	2.1130	13.08***	1.1332	3.60***	2.1530	13.70***	1.5352	4.94***	1.4045	8.94***	0.8574	2.63***
Reinsurance ceded	0.1278	36.04***	0.0526	5.86***	0.1279	36.20***	0.0542	6.05***	0.1296	36.92***	0.0602	6.46***
Reinsurance assumed	−0.2589	−96.45***	−0.0908	−13.33***	−0.2588	−96.69***	−0.0900	−13.23***	−0.2573	−96.87***	−0.0813	−11.50***
Mix of business	−0.0736	−11.69***	−0.2382	−15.02***	−0.0741	−11.83***	−0.2431	−15.37***	−0.0909	−15.36***	−0.3717	−23.57***
Regulation dummy	0.0010	0.20	0.0052	0.40	0.0018	0.34	0.0125	0.96	−0.0083	−1.63	0.0452	3.34***
Stock ownership dummy	0.0544	14.09***	0.0675	6.86***	0.0565	15.32***	0.0919	9.87***	0.0686	18.05***	0.0467	4.61***
Group dummy	0.0066	1.55	−0.0259	−2.49**	0.0070	1.65*	−0.0247	−2.39**	0.0225	5.67***	0.0076	0.72
Agent dummy	0.1649	12.84***	0.0133	1.20	0.1669	13.46***	0.0322	3.01***	0.0492	4.17***	−0.0630	−5.57***
Mix of business × regulation	0.0089	1.19	−0.0055	−0.28	0.0082	1.09	−0.0158	−0.82	0.0174	2.32**	−0.0149	−0.75
Adjusted R^2	0.236		0.120		0.237		0.122		0.243		0.050	
Observations	33,440		33,440		33,440		33,440		33,440		33,440	

***Significant at 1% level, **significant at 5% level, and *significant at 10% level.
Note: The efficiency variables are treated as endogenous.

TABLE 7
Price and Profitability Regressions by Year: Estimated by Two-Stage Weighted Least Squares

	1992				1993				1994			
Dependent Variables	Profit		Price		Profit		Price		Profit		Price	
Independent Variables	Coeff.	*t*-Ratio	Coeff.	*t*-Ratio	Coeff.	*t*-Ratio	Coeff.	*t*-Ratio	Coeff.	*t*-Ratio	Coeff.	*t*-Ratio
Intercept	−0.9096	−5.01***	4.4386	15.07***	−1.8867	−12.24***	3.6710	12.33***	−1.4124	−8.44***	3.8717	13.74***
Concentration	3.0153	4.30***	10.9152	6.63***	1.5172	2.44**	5.0251	3.01***	0.8774	1.32	6.3781	3.66***
Market share	−0.6150	−0.57	−6.9320	−2.77***	−3.9788	−2.36**	−12.4422	−2.78***	−2.9091	−1.56	−10.1613	−2.16**
Cost X-efficiency	0.7148	8.44***	−2.1334	−11.28***	0.7625	9.41***	−2.0356	−10.00***	0.8939	14.51***	−1.8442	−11.96***
Cost scale-efficiency	−0.5177	−5.76***	−1.3577	−8.04***	0.2300	3.05***	−1.0005	−5.96***	0.0432	0.52	−0.8990	−5.28***
Revenue X-efficiency	0.3642	8.66***	0.0408	0.44	0.3300	7.40***	−0.0693	−0.65	0.2133	5.49***	0.0292	0.30
Revenue scale-efficiency	0.3812	2.59***	0.0995	0.52	1.0168	7.79***	0.6902	3.48***	0.5888	4.27***	0.0214	0.12
Market growth	−0.2687	−2.61***	−1.1299	−4.67***	0.0191	0.25	0.2658	1.32	0.1895	1.78*	0.2475	0.89
Advertising intensity	3.2197	9.52***	1.0455	1.60	0.8910	2.80***	0.6801	0.95	1.7447	4.13***	2.0104	2.42**
Reinsurance ceded	0.1432	13.42***	0.0940	3.75***	0.1178	11.90***	0.0371	1.40	0.1043	10.53***	0.0861	3.47***
Reinsurance assumed	−0.2867	−37.93***	−0.0857	−4.87***	−0.2819	−41.21***	−0.0741	−4.04***	−0.2218	−27.65***	−0.1327	−6.45***
Mix of business	−0.0191	−1.07	−0.1877	−4.54***	−0.0962	−6.02***	−0.2210	−5.24***	−0.1259	−8.13***	−0.3423	−8.61***
Regulation dummy	−0.0466	−3.08***	−0.0676	−1.90*	−0.0048	−0.37	0.0074	0.21	−0.0273	−2.23**	−0.0763	−2.38**
Stock ownership dummy	0.0603	5.53***	0.0981	3.88***	0.0368	3.53***	0.0503	1.82*	0.0855	8.60***	0.1176	4.53***
Group dummy	0.0026	0.21	−0.0270	−0.96	−0.0085	−0.80	−0.0250	−0.92	−0.0112	−1.07	0.0456	1.76*
Agent dummy	0.2718	8.33***	−0.0706	−2.29**	0.0393	1.37	−0.0190	−0.62	0.1162	3.86***	0.0089	0.30
Mix of business × regulation	−0.0108	−0.49	−0.0628	−1.21	0.0113	0.59	−0.0125	−0.24	0.0458	2.47**	0.0544	1.12
Adjusted R^2	0.262		0.120		0.285		0.092		0.186		0.134	
Observations	4,403		4,403		4,944		4,944		5,024		5,024	

(*continued*)

TABLE 7
(Continued)

	1995				1996				1997			
Dependent Variables	Profit		Price		Profit		Price		Profit		Price	
Independent Variables	Coeff.	*t*-Ratio	Coeff.	*t*-Ratio	Coeff.	*t*-Ratio	Coeff.	*t*-Ratio	Coeff.	*t*-Ratio	Coeff.	*t*-Ratio
Intercept	−2.0027	−10.54***	3.4928	10.94***	−0.6651	−4.06***	5.5314	17.73***	−1.3557	−8.72***	4.6340	14.28***
Concentration	1.1993	1.42	5.2241	2.45**	1.0771	1.48	9.4388	5.01***	−2.8337	−3.61***	−2.4489	−1.16
Market share	−3.3209	−2.03**	−11.1997	−2.78***	−2.8822	−1.90*	−17.8925	−4.63***	−0.7781	−0.50	−16.5050	−4.06***
Cost X-efficiency	0.8039	11.37***	−1.7144	−9.60***	0.5080	6.08***	−2.1477	−10.50***	0.6714	7.54***	−2.5432	−11.41***
Cost scale-efficiency	0.2275	3.17***	−1.1545	−7.14***	−0.2494	−3.15***	−2.5784	−14.30***	−0.1813	−2.69***	−1.9535	−11.44***
Revenue X-efficiency	0.2754	5.68***	0.3953	3.23***	0.2597	5.88***	0.4832	4.54***	0.4540	7.73***	0.8842	6.38***
Revenue scale-efficiency	1.0244	6.86***	0.4686	2.45**	0.4769	3.73***	−0.0612	−0.32	0.7595	5.37***	0.5114	2.48**
Market growth	−0.3332	−2.79***	−1.5860	−5.33***	−0.0844	−0.78	−0.9313	−3.34***	−0.1436	−1.23	−0.9733	−3.10***
Advertising intensity	2.3221	5.88***	2.1831	2.69***	−0.4754	−1.06	−1.4043	−1.47	5.1640	5.73***	2.4672	1.24
Reinsurance ceded	0.1075	12.36***	0.0661	3.05***	0.1333	15.31***	0.0496	2.23**	0.1218	13.21***	0.0567	2.31**
Reinsurance assumed	−0.2321	−36.31***	−0.0893	−5.55***	−0.2470	−37.44***	−0.0991	−5.83***	−0.2565	−38.17***	−0.0890	−4.93***
Mix of business	−0.0850	−5.28***	−0.3109	−7.76***	−0.1107	−6.91***	−0.3521	−8.56***	−0.0216	−1.31	−0.1944	−4.42***
Regulation dummy	−0.0027	−0.21	0.0293	0.90	−0.0447	−3.39***	−0.1102	−3.24***	0.0485	3.62***	0.1090	3.00***
Stock ownership dummy	0.0365	3.73***	0.0062	0.25	0.0763	7.65***	0.1190	4.63***	0.0439	4.46***	0.0392	1.49
Group dummy	0.0223	2.11**	0.0090	0.36	−0.0065	−0.60	−0.0912	−3.31***	−0.0210	−1.88***	−0.1574	−5.45***
Agent dummy	0.1694	6.36***	0.0378	1.42	−0.0251	−0.93	−0.0275	−0.97	0.1486	4.50***	0.1082	3.54***
Mix of business × regulation	0.0026	0.14	−0.0100	−0.21	0.0629	3.29***	0.1505	3.04***	−0.0377	−1.94*	−0.0678	−1.28
Adjusted R^2	0.218		0.126		0.259		0.169		0.258		0.146	
Observations	4,978		4,978		4,819		4,819		4,697		4,697	

(*continued*)

TABLE 7
(Continued)

	1998			
	Profit		Price	
Dependent Variables Independent Variables	Coeff.	*t*-Ratio	Coeff.	*t*-Ratio
Intercept	−0.2587	−1.63	5.0477	15.55***
Concentration	−0.7057	−0.79	−0.8692	−0.40
Market share	3.4380	1.98*	0.9967	0.23
Cost X-efficiency	0.8638	9.62***	−2.2783	−10.56***
Cost scale-efficiency	−0.6845	−9.31***	−2.4653	−13.81***
Revenue X-efficiency	0.2080	4.26***	0.2543	2.22**
Revenue scale-efficiency	−0.2025	−1.36	0.3749	1.89*
Market growth	−0.4341	−2.95***	−0.9285	−2.57**
Advertising intensity	2.3832	4.61***	0.5357	0.55
Reinsurance ceded	0.1629	15.90***	0.0177	0.71
Reinsurance assumed	−0.2836	−34.57***	−0.0966	−4.85***
Mix of business	−0.0117	−0.62	0.0274	0.59
Regulation dummy	0.0785	5.03***	0.1700	4.44***
Stock ownership dummy	0.0387	3.43***	0.0477	1.72*
Group dummy	0.0655	4.82***	0.0482	1.52
Agent dummy	0.2329	7.04***	0.0182	0.57
Mix of business × regulation	−0.0063	−0.29	−0.1112	−2.04**
Adjusted R^2	0.244		0.118	
Observations	4,575		4,575	

***Significant at 1% level, **significant at 5% level, and *significant at 10% level.
Note: Efficiency variables are treated as endogenous in all models.

With respect to profit, revenue X-efficiency and revenue scale-efficiency are associated with higher profit; and these relationships are significant at the 10 percent level or better in both models. For cost X-efficiency and cost scale-efficiency, the results are a little mixed. Cost scale-efficiency is positively related to profits in both models in Table 3, and the coefficient is significant at the 10 percent level or better. Positive coefficients support the ES hypothesis and signify that, ceteris paribus, firms that are more cost scale-efficient earn higher profits.

The signs of the control variables in Table 3 are mostly as expected. The positive and significant coefficients on the advertising-intensity variables in the company price and profit models indicate that advertising-intensity is associated with higher profits and prices. This is consistent with the hypothesis that advertising-intensity promotes firm recognition and brand loyalty. In addition, it lends support to the argument that advertising-intensity raises the cost of entry, and therefore contributes to a barrier to entry (Brozen, 1982; Shepherd, 1986). The advertising-intensity result is consistent also with the findings of Gardner and Grace (1993) that life insurer rate of return is positively related to advertising. The coefficient for the independent agency system dummy variable is positive and significant in the company price model and insignificant in all other models. The company model results in Table 3 suggest that the independent agency system is associated with higher prices and no difference in profitability, everything else held constant (at least for the company models). The results in the company profit models are consistent with Berger, Cummins, and Weiss (1997).

The signs on the reinsurance-ceded variable (defined as reinsurance ceded divided by direct premiums written) are positive and significant in all models in Table 3, consistent with Berger, Cummins, and Tennyson (1992). In the latter research, insurer profitability is found to be positively related to the proportion of reinsurance ceded. However, a positive coefficient for reinsurance ceded can occur as a result of the expense allocation process used to find profit, as discussed in the data section. Similarly, the observed negative and significant coefficient for reinsurance assumed percent may be related to the expense allocation process. Thus, no firm conclusions should be made about reinsurance from this analysis.

Stock Ownership is found to be positively related to prices and profits in all models in Table 3; and it is significantly related to profits in both models, suggesting that stock insurers charge higher prices and earn higher profits. This is consistent with the managerial discretion hypothesis if stock companies write riskier, more complex insurance (Mayers and Smith, 1994). Association with a group is negatively and significantly related to profit in the group price and profit models. Markets in which insurance is growing (as measured by growth in direct premiums written in a state from year to year) are associated with lower prices and profitability in three of the four models, and these relationships are significant. The mix of business variables are negatively related to prices and profits in Table 3, and the relationships are significant at the 1 percent level. This signifies that prices and profits are lower for firms that write a greater share of business in the personal (versus commercial) lines.

The signs for the regulation dummy variables are negative and significant in three of the models in Table 3, and these results are consistent with rate supression during the time period studied. Partially offsetting this result are the results with respect to the interaction between business lines mix and regulation. The coefficients for the interaction term are positive and significant in two of the models in Table 3. The latter results indicate that prices and profit for insurers writing personal lines in regulated states are relatively higher than for nonregulated states, ceteris paribus. But the test for regulation may be rather limited in these models since it assumes the effect of regulation can be collapsed into a dummy variable and interaction term.

The results in Table 4 (obtained from two-stage WLSs) are consistent overall with the results in Table 3. Focus is placed in the discussion of this table on the efficiency, market share, and concentration ratio variables since these variables are used to test the main hypotheses. Concentration is significant and positive in all models in Table 4, supporting the SCP hypothesis. The signs on the market share variables are negative in all models, and the negative signs are significant in three of the models (company price model, group profit model, and group price model). Thus, the results in Table 4 (like those in Table 3) do not support the RMP hypothesis. Cost X-efficiency is negatively related to price and significant at the 1 percent level in all models in Table 4. Cost X-efficiency is positively related to profit in both models. The coefficients in the price and profit equations are consistent with the ES hypothesis. Cost scale-efficiency is negatively related to price in both models in Table 4, and the coefficient is positive and significant in the group profit model, signifying that prices are lower for more cost scale-efficient firms, providing some support for ESS. The coefficients for revenue X-efficient and revenue scale-efficient firms are positive and significant in all models, indicating that insurance companies and groups that are more revenue efficient charge higher prices and earn higher profit.

Discussion of Price and Profit Regressions Results From Equations 1 and 2

Taken together, the positive coefficients for concentration in the price *and* profit models both support SCP. The negative coefficients for the market share in most of the models reported in Tables 3 and 4 suggest that firms do not exercise market power to raise profits and prices. Only the results in the group profit model in Table 3 are contrary to this conclusion. Negative coefficients for market share have been reported in some past banking studies as well (e.g., Berger, 1995; Goldberg and Rai, 1996). The results for cost X-efficiency in the price models indicate that cost X-efficiency is associated with lower prices. Thus, there is evidence that consumers benefit from increases in cost X-efficiency. The positive coefficients for cost X-efficiency in the profit equations in Table 4 suggest that insurers probably benefit from cost X-efficiency in the form of higher profits.

Firms that are revenue efficient are associated with higher prices *and* higher profits. The positive signs on the revenue efficiency variables may provide some support for insurer interest in cross-selling different types of financial products to consumers. It is here that price distortions may lead to higher prices, potentially allowing insurers to benefit more than consumers. Offsetting these higher prices are any savings in search costs for customers. Unfortunately, these search costs are not quantifiable.[24]

[24] The R^2 reported for the price equations may appear to be low. However, R^2 of the same magnitude (or lower) are reported also in previous banking studies. For examples, see Smirlock (1985), Evanoff and Fortier (1988), Berger (1995), and Berger and Hannan (1993, 1998).

So, overall, the results suggest that regulators should focus on insurer efficiency and concentration rather than market power in their regulatory activities. Recall that group data were used in the models to determine if it is the group (versus individual companies) that wields market power and/or produces distortions in state insurance markets. If it were groups rather than individual companies having an impact on state market structure, then insignificant (or less significant) signs for market share, concentration, and efficiencies would be expected in the models using individual company data versus the group data models. The results do not bear this out. In the price models in Table 3, the consistency and significance of the coefficients for the key variables using *company data* are stronger for concentration and market share. There are virtually no differences in the signs and significance of the coefficients for the efficiency-related variables in Tables 3 and 4. However, in the group models in Tables 3 and 4, the sign of the market share variable changes, and the coefficients are significant in Tables 3 and 4. On the contrary, the market share variables in the profit models in Tables 3 and 4 are never significant in the company models. In the profit model in Table 3, the concentration variable has a positive and significant coefficient, while it is insignificant in the group model in Table 3. Therefore, to streamline the discussion in the remainder of the results section, the focus is on the results using individual company data. However, comparable group results for the models in Table 6 are provided in Appendix 2.

Modified Price and Profit Regressions Results

As suggested by Berger (1995), price and profit models are estimated that exclude direct measures of efficiency to determine the effect, if any, on the market share and concentration variables. In other words, whether a variable such as market share proxies for efficiency when direct measures of efficiency are eliminated from the analysis can be determined by estimating the model without the efficiency variables and comparing the new results with the full model. Also, price and profit models are estimated that exclude market share and concentration but retain the efficiency variables to determine the effect, if any, on the efficiency variables under this specification. Table 5 contains the profit and price models estimated by GMM and H2SLS, while Table 6 contains two-stage WLS results. There are no differences in signs and significance among the market share, concentration, and efficiency variables in the models in Tables 5 and 6, except that concentration becomes insignificant in the profit model that excludes the efficiency variables in Table 6. Thus, the market share, concentration, and efficiency coefficients do not appear to act as proxies for each other when one set of variables is excluded from the model (except perhaps for the concentration variable in the two-stage WLS profit model in Table 6).

Price and Profit Models Regression Results by Year

Catastrophes significantly affect the property-liability insurance industry as a whole, and two catastrophes occurred over the sample period (i.e., Hurricanes Andrew and Iniki in 1992 and the Northridge Earthquake in 1994). The purpose of this section is to investigate whether the occurrences of catastrophes during some sample years have a bearing on the results. To determine whether the results reported in Tables 3 and 4 are affected by catastrophes, Equations (1) and (2) are run separately for each year of the sample period (i.e., 1992–1998). The effect of regulation can vary among years according to some rate regulation theories (e.g., regulatory lag); the year regressions allow the coefficients of the regulation variables to vary among years. Thus, the year regressions may shed some light on this phenomenon as well. The results are reported in Table 7.

These results indicate that in all sample years, cost X-efficiency and cost scale-efficiency are negatively related to price, and the coefficients are significant at the 1-percent level or better in all sample years. In the profit models, cost X-efficiency is positively associated with profit at the 1-percent level or better for all sample years. These results in the price and profit models strongly support the ES hypothesis. However, cost scale-efficiency is negatively related to profit in some instances. One possible explanation for this is that the benefits from cost X-efficiency and the revenue efficiencies come at the expense of scale efficiency.[25]

Overall, revenue X-efficiency and revenue scale-efficiency are positively related to price and significant in 1995–1998 for revenue X-efficiency and 1992, 1994, and 1996 for revenue scale-efficiency. Revenue X-efficiency and revenue scale-efficiency are positively related to profit and significant in all years except for revenue scale-efficiency in 1 year. Thus, overall, revenue X-efficiency and/or revenue scale-efficiency are associated with higher prices and higher profits during the individual years of the sample. This relationship, in general, is not related (or restricted) to sample years associated with a catastrophe.

On the other hand, the coefficients for the market share and concentration variables fluctuate in sign and significance among the sample years. The coefficients for market share are negative in both the price and profit models in Table 7, except for 1998. Positive signs are expected in both the price and profit equations under RMP. The concentration variable in the price models tend to be positive and significant during 1992–1995. In the profit models, the coefficients for concentration are positive and significant in 1992 and 1993. Under SCP, a positive and significant sign is expected for this variable. Thus, overall, the results provide less support for the RMP or SCP hypotheses compared to the ES hypothesis. Again, these results do not seem to be systematically related to whether a catastrophe occurred in a specific year or not.

With respect to regulation, the coefficients for the regulation dummy variable and their significance are parallel in the price and profit models. But the signs and significance for this variable fluctuate among the sample years. This result is consistent with a regulatory environment that fluctuates in stringency over the years. Nevertheless, the efficient structure hypothesis is supported by the yearly regressions. The interaction term between regulation and mix of business fluctuates in sign and significance among the years; in the price model, it is mostly insignificant while in the profit model, it is significant about one-half of the time. The results for the remaining variables in Table 7 are consistent with those in Table 4 overall except that some coefficients are not significant in some years. Also, the sign and significance of the group variable fluctuate among the years.

[25] For example, it is theoretically possible that underwriting skimming of the best customers in the market increases cost X-efficiency at the expense of operating at a lower scale.

CONCLUSION

This study examines the relationships among market structure and performance in property-liability insurers over the period 1992–1998. X-efficiency and scale-efficiency are explicitly incorporated into the analysis. Cost and revenue efficiencies are examined, and this is the first research to use revenue efficiency to explain market structure and performance. Four specific hypotheses are examined: SCP, RMP, ESS hypothesis, and ESX hypothesis. Company and group data at the state level are used to investigate the four hypotheses. The results support the ES hypothesis for the sample period as a whole. By-year regressions also support the efficient structure hypothesis overall for each sample year. Thus, the results show some robustness to the occurrence of catastrophes and changing regulatory stringency. In addition, the results indicate that it is important to control for efficiency in examining performance in this industry. Otherwise, spurious correlations between market structure, conduct, and performance may be observed.

The implications of this research suggest that regulators should be more concerned with efficiency (both cost and revenue) rather than market power that may arise from consolidation. In fact, this research suggests that market share is negatively related to price and profit rather than positively. Concentration is positively related to profits and prices, although the relationship between concentration and profit and prices appears to be weaker in the later years of the sample period (i.e., 1997–1998).

It is important to note that cost X-efficiency is associated with lower prices and higher profitability for insurers. However, revenue X-efficiency is positively related to profit and price, indicating that consumers may derive less benefit from revenue X-efficiencies than insurers. Revenue X-efficiency-related activities then should be of interest to regulators. Cross-selling is one type of revenue efficiency, but cross-selling may involve privacy issues. The debate rages still about privacy issues in the Gramm-Leach-Bliley Act of 1999.

APPENDIX

TABLE A1
Summary Statistics for Efficiency Variables

	Company		Group	
Variables	Mean	Standard Deviation	Mean	Standard Deviation
Cost	75.99	341.82	77.55	361.58
Revenue	65.46	323.73	69.06	361.90
Price of labor input	1.057	0.169	1.051	0.147
Price of agent input	1.017	0.134	1.018	0.136
Price of material input	1.273	0.228	1.264	0.226
Price of equity capital input	0.116	0.057	0.113	0.056
Price of long-tail personal lines output	0.495	0.273	0.472	0.264
Price of short-tail personal lines output	0.636	0.284	0.605	0.277
Price of long-tail commercial lines output	0.736	0.391	0.751	0.395
Price of short-tail commercial lines output	0.400	0.289	0.416	0.298
Price for real investment output	0.071	0.044	0.072	0.053
Labor input	18.33	80.43	19.09	89.53
Agent input	22.67	102.14	23.25	109.41
Material input	22.90	100.93	23.92	113.95
Equity capital input	178.36	936.64	182.67	942.69
Long-tail personal lines output	50.22	394.76	55.78	447.13
Short-tail personal lines output	22.87	230.11	27.80	249.45
Long-tail commercial lines output	40.32	139.97	36.50	113.57
Short-tail commercial lines output	18.71	67.69	17.82	55.85
Output volume for real invested assets	478.83	2093.05	479.40	2137.79

Note: Quantities are in millions of real 1992 dollars.
Cost is the sum of the operating expenses and the cost of capital (i.e., total expenses minus loss adjustment expenses plus cost of capital).
Revenue includes premiums earned (adjusted for the present value of losses) plus investment income.

TABLE A2
Profitability and Price Regressions With and Without Controls for Efficiency, 1992–1998: Estimated by Two-Stage Weighted Least Squares: Group Results

	Full Sample				W/O MS & CONC				W/O Efficiency Variables			
Dependent variables	Profit		Price		Profit		Price		Profit		Price	
Independent variables	Coeff.	*t*-Ratio	Coeff.	*t*-Ratio	Coeff.	*t*-Ratio	Coeff.	*t*-Ratio	Coeff.	*t*-Ratio	Coeff.	*t*-Ratio
Intercept	−0.8219	−17.24***	3.3445	22.38***	−0.8048	−17.24***	3.5410	24.04***	0.1096	9.25***	1.3242	35.18***
Concentration	0.4635	2.25**	4.9424	7.65***					−0.2674	−1.27	3.4011	5.08***
Market share	−1.8875	−6.25***	−5.6085	−5.93***					−2.5589	−8.26***	−7.0596	−7.17***
Cost X-efficiency	0.4383	15.31***	−2.1268	−23.71***	0.4425	15.69***	−2.1802	−24.50***				
Cost scale-efficiency	0.0829	3.06***	−1.5169	−17.86***	0.0768	2.89***	−1.4558	−17.40***				
Revenue X-efficiency	0.4922	32.00***	1.0485	21.75***	0.4982	32.83***	1.0384	21.69***				
Revenue scale-efficiency	0.0649	2.33**	0.2910	3.34***	0.0372	1.36	0.2264	2.63***				
Market growth	0.0933	2.69***	0.1733	1.60	0.1198	3.52***	0.3329	3.10***	0.0420	1.16	0.0545	0.48
Advertising intensity	−0.0428	−0.22	0.5494	0.90	0.1492	0.78	1.0567	1.76*	−0.6906	−3.52***	2.2019	3.53***
Reinsurance ceded	0.0858	14.25***	0.0860	4.56***	0.0868	14.49***	0.0914	4.84***	0.0968	15.50***	0.1050	5.29***
Reinsurance assumed	−0.1857	−31.25***	−0.1760	−9.45***	−0.1865	−31.57***	−0.1761	−9.45***	−0.1882	−30.32***	−0.1850	−9.39***
Mix of business	−0.0053	−0.71	−0.2046	−8.75***	−0.0142	−1.95*	−0.2361	−10.27***	0.0148	2.01**	−0.3834	−16.35***
Regulation dummy	0.0667	12.43***	0.0390	2.32**	0.0694	13.11***	0.0578	3.46***	0.0689	12.37***	0.1081	6.11***
Stock ownership dummy	0.0135	4.28***	−0.0203	−2.04**	0.0162	5.20***	−0.0096	−0.98	0.0376	11.74***	0.0068	0.67
Group dummy	−0.0111	−3.40***	−0.0422	−4.12***	−0.0127	−3.92***	−0.0466	−4.55***	−0.0173	−5.33***	0.0651	6.31***
Agent dummy	0.0354	3.75***	0.3905	13.17***	0.0565	6.49***	0.4385	15.96***	−0.0547	−6.30***	0.4286	15.56***
Mix of business × regulation	−0.0607	−7.47***	−0.0271	−1.07	−0.0637	−7.90***	−0.0324	−1.27	−0.0640	−7.56***	−0.0444	−1.65*
Adjusted R^2	0.130		0.129		0.139		0.126		0.050		0.023	
Observations	20,836		20,836		20,836		20,836		20,836		20,836	

***Significant at 1% level, **significant at 5% level, and *significant at 10% level.
Note: Two-stage weighted least squares is used to estimate all models with efficiency-related variables, and the efficiency variables are treated as endogenous.

TABLE A3
Sample Distribution—By Year and State

Year State	1992	1993	1994	1995	1996	1997	1998	Total
Alabama	104	110	105	111	109	96	90	725
Alaska	67	66	63	66	68	63	58	451
Arizona	100	105	111	99	100	94	89	698
Arkansas	98	105	107	108	98	95	93	704
California	105	105	114	112	114	115	106	771
Colorado	90	96	100	103	111	102	94	696
Connecticut	104	108	109	111	109	101	101	743
Delaware	69	72	74	66	70	77	78	506
Florida	93	113	118	120	119	116	108	787
Georgia	121	122	132	123	119	116	105	838
Hawaii	43	53	58	50	51	41	46	342
Idaho	76	88	88	83	81	92	87	595
Illinois	120	122	127	123	117	110	108	827
Indiana	102	115	116	112	103	91	102	741
Iowa	115	117	120	115	115	97	108	787
Kansas	102	101	104	106	104	102	105	724
Kentucky	126	117	117	111	111	105	107	794
Louisiana	79	86	91	95	81	82	82	596
Maine	72	72	79	83	82	73	69	530
Maryland	95	92	97	90	90	95	84	643
Massachusetts	76	81	89	98	93	99	88	624
Michigan	84	92	87	89	70	73	73	568
Minnesota	112	116	116	118	110	105	107	784
Mississippi	95	107	106	104	94	95	92	693
Missouri	118	120	123	125	111	111	107	815
Montana	95	98	91	89	91	90	86	640
Nebraska	104	113	108	95	106	88	94	708
Nevada	81	81	91	95	97	89	88	622
New Hampshire	92	92	90	104	100	94	92	664
New Jersey	100	98	97	99	96	94	88	672
New Mexico	92	91	81	85	87	87	79	602
New York	107	109	123	122	117	118	109	805
North Carolina	100	111	112	103	96	104	99	725
North Dakota	89	89	87	89	83	74	92	603
Ohio	96	96	98	101	83	88	86	648
Oklahoma	92	100	102	98	95	86	85	658
Oregon	87	96	90	91	87	95	82	628
Pennsylvania	112	117	114	110	108	109	101	771
Rhode Island	83	79	98	92	97	92	89	630
South Carolina	78	87	84	81	79	71	79	559
South Dakota	95	97	101	101	98	91	99	682
Tennessee	115	115	117	113	118	114	124	816
Texas	89	91	88	95	89	85	71	608
Utah	103	94	98	98	88	96	95	672
Vermont	78	90	83	92	91	90	84	608
Virginia	95	98	102	99	100	99	98	691
Washington	93	102	101	102	91	103	93	685
West Virginia	77	69	70	63	64	60	55	458
Wisconsin	103	112	111	103	100	102	94	725
Wyoming	81	88	86	87	78	82	76	578
Total	4,703	4,894	4,974	4,928	4,769	4,647	4,525	33,440

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