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An Empirical Investigation of the Structure and Performance of the Private Workers' Compensation Market

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ABSTRACT

Although a number of studies have focused on the relationship between market characteristics and market performance for the automobile insurance industry, surprisingly little attention has been devoted to the same type of analysis for workers' compensation insurance despite its being the leading commercial line. This study attempts to fill that gap through an empirical investigation of the structure and performance of the private workers' compensation market using panel data composed of state-years for the period 1980-1987. Two principal hypotheses that relate structure and performance were investigated: the collusion hypothesis and the differential efficiency hypothesis. Neither hypothesis could be fully supported from these results.

Introduction

The current workers' compensation system in the United States, which requires employers to purchase insurance, is premised on the assumption that such a system is the most effective way to deal with the cost of employment-related injuries. Since much of employers' workers' compensation obligation is financed through the private insurance system,[1] it is important to examine the functioning of this market. In a market where insurers are able to earn economic rents, insurers will have welfare gains vis-à-vis the case where there is pure competition, while employers may have welfare losses. Policy-makers might then question whether the private insurance market produces a desirable distribution of the costs of employment-related injuries throughout society. If it is not desirable, then possible options might include "correcting" the private market through regulatory intervention (which could involve deregulation) or replacing private insurance with a government insurance program.

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[1] In 1988, private insurance represented 55.5 percent of the workers' compensation market, including self-insurance (U.S. Census Bureau, 1989, *Statistical Abstract of the United States*).

This analysis examines the market structure for the private workers' compensation insurance market in the context of a structure-performance paradigm to better understand the nature of the competition in this line and whether and how rents occur. Most structure-performance studies focus on explaining the positive relationship typically observed between industry concentration and profitability (see Scherer, 1980, chap. 9, for a review). The industrial organization literature has offered two hypotheses to explain this relationship. The first, attributable to Bain (1951), was the collusion hypothesis, which proposed that concentration facilitates collusion, which increases industry-wide profits. Later, Demsetz (1973) offered an alternative hypothesis which proposed that firms with production advantages capture a larger share of output and at the same time earn economic rents.

From a public policy standpoint, which of these hypotheses more accurately describes reality for the workers' compensation line is important for determining appropriate regulatory remedies. In the case of collusion, a policy that would promote the dilution of concentration would benefit employers by lowering prices. On the other hand, that same policy would punish efficiency if the alternative hypothesis holds true.

This empirical investigation explores both hypotheses using a simultaneous equations approach. The sample comprised of pooled cross-sectional time series data using 29 states, where the unit of observation is state-years for the period 1980 through 1987.

The next section reviews previous studies on structure and performance in the automobile and workers' compensation lines and presents the theoretical basis for the hypothesis testing. The empirical specification of the model is then presented and is followed by the results of the tests.

Background and Theoretical Foundations

Previous Studies

A number of studies report or provide information on the structure-performance relationship in the property-liability insurance industry. Most of these studies, however, focus on automobile insurance; few studies examine workers' compensation insurance despite its being the leading commercial line.

Joskow's (1973) pioneering study concluded that the structure of the auto and fire markets are basically competitive: a large number of firms sell an essentially homogeneous product in a market where there are constant returns to scale and low to moderate entry barriers. But he notes that rating bureaus in combination with prior approval ratemaking may discourage price competition.

Danzon (1983) explored further the impact of rating bureaus on competition in the auto insurance market. She proposed two alternative models for the role of the rating bureau: the cartel model where the bureau sets prices so as to maximize joint profits, and the service model where the bureau provides services for which there may be scale economies. Most of the evidence she examined was consistent with the latter view. Where we would expect the bureau (in this case, the Insurance Services Office [ISO]) to have large market

shares if it acts a cartel, she finds that the ISO market share in each of the states is not large enough to carry any market power. In addition, she found that small rather than large firms were more likely to use ISO rates, which also supports the view that bureaus provide valuable services that may be more efficiently performed at a relatively large scale. Finally, if the bureau were to act as a cartel, the price it would set would be above the profit-maximizing price for an individual insurer so if individual insurers were to cheat, they would do so by charging a price lower than that set by the cartel. Thus, we would expect that most rate deviations filed would be downward. In fact, this was found not to be the case—most deviations filed were upward. Danzon notes, however, that this could reflect product quality differences.

Two notable studies examined workers' compensation insurance. The U.S. General Accounting Office (1987) explored how competitive ratemaking affected the market for workers' compensation insurance by looking at cost and availability of this coverage in competitive rating states before and after the competitive rating law took effect. Although the purpose of the study was not to determine the market structure for this line of insurance, the study does shed some light on a few aspects of the market. Using information gathered from reports on the effects of competitive rating published by several insurance departments of states with competitive rating laws for workers' compensation insurance, the study concludes that there is some preliminary evidence that competitive rating reduces costs. This may imply that prior approval rate regulation may help foster excessive rates and is consistent with Joskow's hypothesis that the combination of prior approval ratemaking and rating bureaus may suppress price competition. The GAO study cautions that further research is necessary to support their conclusions because the time period for their study did not span an entire underwriting cycle.

In another study, Appel and Gerofsky (1985) focused on the structure and performance of the workers' compensation line. They looked at concentration ratios, entry barriers, product feature competition, and excess profits to determine whether the market is workably competitive. For instance, they observed that in 1982 the national concentration ratios for the top four and top eight insurers were 24.4 percent and 38.4 percent, respectively. These are in the range of concentration ratios for industries commonly thought to be competitively structured; however, these ratios do vary considerably by state, with smaller states having higher concentration ratios. In addressing the issue of entry barriers, they cited Joskow in concluding that there are no significant legal or economic barriers to entry, and they noted that the number of insurers writing workers' compensation does ebb and flow with the economy. When it comes to excess profits, they did not supply evidence specifically regarding the workers' compensation line; rather, they cited studies that compared the return on equity for the property-liability insurance industry as a whole with those of other industries and found that profits were not excessive. With no evidence to the contrary, the authors concluded that these results would apply specifically to workers' compensation as well as to the industry as a whole. Accordingly, they concluded that the workers' compensation insurance market was competitive.

The above studies give the impression that the property-liability market leans toward competition but there may be institutional factors that interfere. Both Joskow and Danzon acknowledge that the existence of rating bureaus in combination with prior approval rate regulation may hinder price competition. And the GAO results imply that this may be the case for the workers' compensation line.

Although Appel and Gerofsky provide a useful overview of the workers' compensation market, often the authors draw on studies of the property-liability market as a whole and apply the results specifically to the workers' compensation market without any comment on why this would be a legitimate extension. Danzon, on the other hand, does supply us with the caveat that her conclusions can only be generalized to other lines to the extent that they resemble automobile insurance. In one very significant way the workers' compensation line does differ from the auto line: in many states there is required adherence to bureau rates. Such a requirement may give the bureau more market power which might allow its members to reap above normal profits.

Theoretical Foundations

The theoretical foundation for this empirical investigation is a model developed by Clarke and Davies (1982) that ties together Bain's collusion hypothesis and Demsetz's differential efficiency hypothesis. Clarke and Davies assume that the industry contains N firms that produce a homogeneous good. Cost functions may vary across firms in the industry, but marginal costs are assumed to be constant for each firm over the relevant range of output. These marginal costs have mean μ_c and standard deviation σ_c. The *i*th firm has the following profit equation:

$$\Pi_i = p(X)X_i - c_i(X_i), \tag{1}$$

where Π_i = profit, firm i,
p = price,
c_i = cost, firm i,
X_i = output, firm i,
X = ΣX_i, and
$p(X)$ = inverse market demand function.

If the *i*th firm sets output to maximize profits, the first-order condition for *i* is

$$p(X)\left[1 - \frac{1}{\eta}\frac{X_i}{X}(1+\gamma_i)\right] = c_i'(X_i), \tag{2}$$

where $\eta = \dfrac{-p}{X}\dfrac{dX}{dp}$ = industry price elasticity of demand, and

$\gamma_i = \dfrac{d\Sigma X_j}{dX_i}$ = conjectural variations term, firm i.

The conjectural variations term reflects firm *i*'s guess about how other firms will react to its output changes. Multiplying by X_i and summing over the N firms gives

$$\frac{\Pi}{R} = \frac{H}{\eta}(1+\mu), \tag{3}$$

where $\frac{\Pi}{R} = \frac{\Sigma[X_i p(X) - X_i c_i'(X_i)]}{Xp(X)}$ = industry average price-cost margin,

$H = \Sigma X_i^2/X^2$ = Herfindahl index, and

$\mu = \Sigma \gamma_i X_i^2/\Sigma X_i^2$ = weighted sum of conjectural variations.

Equation (3) shows the positive relationship between concentration (as measured by the Herfindahl index) and profitability that is predicted by both the collusion and differential efficiency hypotheses. Profitability is also positively related to the conjectural variations term, which indirectly measures collusion. This is consistent with the collusion hypothesis.

To illustrate how cost differences among firms affect the relationship in equation (3), Clarke and Davies make an explicit assumption about the nature of collusion, specifically,

$$\frac{dX_j}{dx_i} = \frac{\alpha X_j}{X_i} \text{ for all } j \neq i \text{ and for all i, and } 0 \leq \alpha \leq 1.$$

The parameter α is the proportionate extent to which each firm believes each other firm will react to its output changes and represents the degree of implicit collusion in the industry. When $\alpha = 0$, that is the special Cournot case of no collusion. When $\alpha = 1$, each firm believes that all others will react to output changes so as to maintain market shares and is labeled "perfect collusion" by Clarke and Davies. If α is the same for all *i*, this means that $\gamma_i = \alpha(X/X_i - 1)$.

The first-order condition from equation (3) can be rewritten as

$$p(X)\left[1 - \frac{1}{\eta}\left(\frac{X_i}{X} - \frac{\alpha X_i}{X} + \alpha\right)\right] = c_i'(X_i). \tag{4}$$

Proceeding as before by multiplying by X_i, summing, and rearranging gives

$$\frac{\Pi}{R} = \frac{H(1-\alpha)}{\eta} + \frac{\alpha}{\eta}. \tag{5}$$

To express the Herfindahl in terms of costs, equation (4) can be rearranged as

$$\frac{X_j}{X} = \frac{-\alpha}{1-\alpha} + \frac{\eta}{1-\alpha}\left(1 - \frac{c_i'(X_i)}{p(X)}\right). \tag{6}$$

Note that by assuming α is constant across firms, differences in firm sizes are due solely to cost differences.

By summing equation (6) over the N firms and rearranging, the following expression for price can be obtained:

$$p(X) = \frac{\Sigma c_i'(X_i)\eta}{N(\eta - \alpha) - (1-\alpha)}. \quad (7)$$

Substituting the above equation into equation (6), squaring, then summing gives

$$H = \frac{1}{N} + \left[1 - N\frac{(\eta - \alpha)}{(1-\alpha)}\right]^2 \frac{v_c^2}{N},$$

where v_c is the coefficient of variation of marginal costs.

Support for the differential efficiency hypothesis is found from the positive relationship between H and v_c^2. As cost differentials (v_c) among firms increase, output will become more concentrated in the hands of efficient firms (H rises), and profitability also rises, as equation (5) demonstrates.

In the traditional structure-performance paradigm, firm conduct provides the causal link between the two variables. Structure determines conduct which then determines performance. Stigler (1964) suggested that higher levels of concentration increase the likelihood of effective collusion; that is, $\alpha = f(H)$ and $d\alpha/dH > 0$ (in terms of the variables in the model) so that concentration might imply collusion. But the way that Clarke and Davies's model is formulated $H = f(\alpha)$, with collusion implying concentration. Does an industry become concentrated because of collusion or must there exist a certain degree of concentration before collusion can occur? To accommodate both points of view regarding the relationship between structure and conduct, conduct can be made endogenous. This leaves a system of equations where structure, conduct, and performance are simultaneously determined. The system of equations can be expressed in the following stylized manner:

$$\begin{aligned}
&\textit{Structure } H && = f(\underset{(+)}{\alpha}, \underset{(-)}{\eta}, \underset{(+)}{v_c^2}, \underset{(-)}{N}),\\
&\textit{Conduct } \alpha && = f(\underset{(+)}{H}),\\
&\textit{Performance } \Pi/R && = f(\underset{(+)}{H}, \underset{(+)}{\alpha}, \underset{(-)}{\eta}),
\end{aligned}$$

where the plus and minus signs below the independent variables indicate the expected relationship to the dependent variable if both the collusion and differential efficiency hypotheses hold.

The above equations provide the theoretical basis for regression analyses relating price-cost margins and concentration. However, before such an analysis is undertaken, the structure and the various assumptions underlying the model must be examined to uncover their theoretical and empirical implications.

Clarke and Davies make a number of assumptions to streamline the model so that the basic relationships among the variables are not obscured and to accommodate empirical testing. First, they assume that firms choose output rather than price to maximize profits. This assumption presents little problem when applying the model to workers' compensation insurance since rating bureaus in combination with prior approval ratemaking effectively make price

a given, ex ante, for firms in the market. Ex post, however, insurers may adjust price by granting policyholder dividends.

Second, firms are assumed to have constant marginal costs over the relevant range of output. This assumption implies that there are constant returns to scale. Whether this is a good assumption for the property-liability insurance industry or the workers' compensation line in particular is not clear. Studies of the property-liability industry as a whole give mixed results on the existence of scale economies. Joskow (1973) found constant returns to scale, while Cummins and VanDerhei (1979) and Doherty (1981) found increasing returns to scale. Butler and Worrall (1986) focused on workers' compensation specifically and found evidence for slight economies of scale for private insurers. If there are increasing returns to scale, then Π/R will be understated in equation (5), and H will be understated in equation (8).

Third, it may not be realistic to assume that α does not vary among firms in a given industry. It is possible that α may vary positively with firm size, with small firms believing that they are able to get away with larger output changes than large firms. Or, for a given size firm *i*, α may vary with respect to each different rival *j*; that is, α_i may not be the same for each *j*. If α varies positively with firm size, then Π/R in equation (4) will be understated.[2] Allowing α to vary across firms requires making specific assumptions on how α_i, X_i/X, and $c_i'(X_i)$ are related before the effect of α on H can be discerned. This is beyond the scope of this article.

Fourth, Clarke and Davies assume that N is exogenous, so the issue of entry and exit is not explicitly treated in their model. Entry and exit can be accounted for in empirical testing of the model by acknowledging the effects of entry/exit through their effect on N in the structure equation. A reduced form approach may be used, where variables that affect a firm's decision to enter/exit the market could be substituted for N on the right-hand side of the equation in which the Herfindahl index is the dependent variable. Entry and exit may also be incorporated into the model by including an endogenous entry variable as an explanatory variable in the Herfindahl index equation. This

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[2] This can be shown by rewriting equation (3) with a subscript i on α and defining $s_i = X_i/X$ as $\dfrac{p(X) - c_i'(X_i)}{p(X)} = \dfrac{1}{\eta}[s_i - \alpha_i s_i + \alpha_i]$.

Multiplying by s_i and summing gives $\dfrac{\Pi}{R} = \dfrac{1}{\eta}[H + \Sigma(\alpha_i s_i - \alpha_i s_i^2)]$,

which can be expressed as

$$\frac{\Pi}{R} = \frac{1}{\eta}[H(1-\bar{\alpha}) + \bar{\alpha}] + \frac{1}{\eta}\Sigma(\alpha_i - \bar{\alpha})(s_i - s_i^2), \qquad (9)$$

where $\bar{\alpha} = E(\alpha)$. The difference between the right-hand side of equation (9) and the right-hand side of equation (4) is just the second term in equation (9). If σ_s and σ_α are the standard deviations for s and α and if r represents the correlation between s and α, then this term may be written as

$$r\sigma_s\sigma_\alpha - \Sigma s_i^2(\alpha_i - \bar{\alpha}) + \Sigma s_i(\alpha_i - \bar{\alpha}).$$

If $\Sigma s_i^2(\alpha_i - \bar{\alpha})$ and $\Sigma s_i(\alpha_i - \bar{\alpha})$ are approximately zero, then the sign on r determines whether Π will be under- or overstated.

would necessitate the estimation of an equation where the entry variable is the dependent variable in this system of simultaneous equations.

Lastly, in both the structure and performance equations derived by Clarke and Davies, industry elasticity of demand, η, appears on the right-hand side. This presents an empirical problem since it is difficult (and sometimes impossible) to measure η. Omitting η leaves these equations underspecified and will result in biased ordinary least squares estimates since η is correlated with H, which appears in the performance equation. An admittedly crude way to address this problem would be to use variables assumed to affect elasticity instead of using an estimate of η. Below, I discuss which variables may be appropriate for this purpose and develop the empirical specification of the model for the private workers' compensation insurance market.

Measurement and Estimation Issues

Variables and Their Measurement

Performance is measured by the profit margin, conventionally calculated as (Total Revenue - Total Expenses)/Total Revenue. For an insurer, revenue comes from two primary sources: premiums and investment income. The principal expenses are the payment of claims (losses) and production and marketing costs. Of interest here is the profit margin for the workers' compensation line, measured on a statewide basis. A measurement problem arises since most insurers write more than one line and accurate data on the allocation of investment income and production and marketing expenses by line and by state are not available. However, the calendar year loss ratio, measured as losses incurred/(premiums earned - policyholder dividends), is available by line, by state. Statewide profitability (PRFT) will be measured by

$$\frac{\text{Premiums Earned (statewide) - Losses Incurred (statewide)}}{\text{Premiums Earned (statewide)}},$$

where premiums earned are adjusted for dividends.

Ideally, accident year rather than calendar year loss ratios would be used to measure PRFT; however, accident year data were not available for this study.[3] Accident year data more accurately depict profitability when there is a significant time lag between the payment of premiums and the payment of losses, as there is for workers' compensation. To compensate for this deficiency in calendar year loss ratios, a variable that captures the loss payout pattern will be included as a control variable in the performance equation. The greater the proportion of losses yet to be paid, the longer is the payout tail (on average);

[3] Better still, a profitability measure using discounted cash flow techniques such as the internal rate of return would be used. Such a measure overcomes a significant problem with the traditional accounting measures of profitability: premiums reflect discounting whereas losses do not. To use internal rate of return would require information on premium flow patterns by state (Cummins and Weiss, 1992, pp. 144-145). These data were not available for this study. Discounting is taken into account indirectly by using an interest rate variable in the empirical analysis.

therefore, the ratio of unpaid losses to losses incurred (LEV), a measure of leverage, will be used to capture payout pattern.

Profitability (PRFT) can be rewritten as

$$\text{Profit Margin} + \frac{\text{Marketing Expenses}}{\text{Premiums}} - \frac{\text{Investment Income}}{\text{Premiums}}.$$

Although some expense and investment income data are available on a by-line, by-state basis, the allocation of these items over states and lines is somewhat arbitrary and, therefore, these measures of expenses and investment income contain error. Instead of using these measures, variables that capture expenses and investment income will be included on the right-hand side of the performance equation.

A number of studies provide information that is useful in finding a reasonable measure of expenses. For instance, Joskow (1973) and Cummins and VanDerhei (1979) observed that direct writers have lower costs than independent agency writers. However, it is unclear whether these lower costs represent an efficiency advantage since it is difficult to control for quality differences. D'Arcy and Doherty (1990) provide theoretical and empirical evidence supporting the direct writer efficiency advantage. Specifically, they argue that the advantage direct writers have is an information advantage. Information regarding the profitability of a policyholder is revealed to both agent and insurer over the life of the insurance contract as the policyholder incurs (or does not incur) losses. If the policyholder's loss experience is favorable, the policy is renewed and rents will be captured by the insurer. Clearly, this information has value to the insurer, but can the agent make money by trading this information? Whereas independent agents, because they deal with several insurers, are in a position to trade this information, direct writer agents cannot since they are bound to one insurer.[4] Direct writer insurers do not have to share with agents the rents generated from the information acquired from policyholder experience, making for lower production and marketing expenses. To capture expenses, then, the direct writers' share (based on direct premiums written) of the state market will be used. This variable will be denoted as DWSHR. If the direct writer cost advantage is due in part to quality differences, then DWSHR may be capturing to some extent the average demand for product quality (Pauly, Kunreuther, and Kleindorfer, 1986).

Assuming that expected investment returns are constant across states but vary over time as interest rates change, an interest rate variable is included on the right-hand side of the performance equation to pick up the investment

[4] Agents for direct writers cannot trade on information related to existing insureds to capture rents from asymmetric information. However, to secure new business, these agents can gain access to loss information on prospective insureds by getting permission to get their loss experience from the bureau. Independent agents can do this as well. Again, independent agents are able to capture rents from asymmetric information related to their existing, not new, business. This private information may include things other than loss experience, like the character of management.

income component of profitability. The rate on intermediate term government bonds (ITRATE) will be used to capture changes in interest rates.[5] In fact, it has been found that price-cost margins for property-liability insurance are inversely related to the level of interest rates (Cummins and Harrington, 1985). This result is consistent with the capital asset pricing model (Fairley, 1979), which says that underwriting returns should equal a risk premium reflecting the systematic risk of underwriting less the riskless return on policyholder funds. In addition, because interest rate changes may affect reserving practices of insurers (and thus affect their accounting profitability), the interaction of ITRATE and LEV (LEV_RATE) also is included as a control variable in the performance equation.

Finally, in measuring profitability for workers' compensation, it should be recognized that this coverage is often purchased by employers in conjunction with other coverages, such as other liability (i.e. insurers engage in account underwriting). Account underwriting may prove advantageous to insurers in attracting accounts. For instance, an insurer may be willing to accept an employer's substandard other liability business if it expects underwriting profitability on the workers' compensation business to be good.[6] Therefore, to control for the effect of account underwriting on workers' compensation profitability, the loss ratio for other liability (OLLR) is included as a control variable in the performance equation.

The collusion measure, α, though in theory observable, cannot be measured since the data needed to do so are simply not available. In place of α, a measurable proxy variable is used. If the bureau acts as a cartel and thus sets rates to maximize joint profits,[7] an individual insurer stands to gain if it independently undercuts bureau rates; that is, gains may be made if an insurer "cheats" on the cartel agreement (see Danzon, 1983).[8] How effective the cartel agreement is (whether it is explicit or implicit) can be gauged by the extent to which insurers adhere to bureau rates; the lower the degree of adherence to bureau rates, the weaker the cartel agreement. The National Council on Compensation Insurance (NCCI) has made available for this study, for the states using its services, statewide rate deviations and departures due to schedule rating, as a percent of standard earned premiums. Combined (PDEP),

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[5] Ibbotson Associates (1990) measures this rate using a one-bond portfolio with a maturity near five years. To the extent that cash flow underwriting practices are a function of interest rates, including ITRATE should capture these pricing devices.

[6] It is also advantageous to insurers to underwrite both type of coverages if there are economies of scope.

[7] In the case where the bureau is aware that regulators are under pressure to keep rates low, the bureau, in order to hasten the rate approval process and preserve any political goodwill, may submit rates that do not maximize joint profits. In any case, the rates finally approved by regulators may differ from the rates submitted by the bureau.

[8] An insurer may deviate in an upward direction in order to signal that it faces a short-run capacity constraint (Tirole, 1989, pp. 365-374).

they represent the statewide weighted average departure from bureau rates.[9] PDEP may take on positive and negative values. Positive values would represent upward departures from bureau rates, and negative values represent downward departures. This variable is almost always negative for the sample period chosen; on average, only one state per year had a weighted average upward departure.

Because it captures the extent of adherence to bureau rates, PDEP provides a rough measure of the effectiveness of the cartel and thus the degree of collusion. The deeper the downward departure, the lower the degree of adherence to bureau rates and the lower the degree of collusion. Conveniently, although this measure is not bounded between zero and one as α is, it is like α in that higher values indicate a greater degree of collusion and lower values indicate a lesser degree of collusion.

Implicit in the above discussion was the assumption that private workers' compensation insurance is a homogeneous product. If, in fact, there are product quality differences, then pricing below bureau rates may not give rise to additional profits for the deviating insurer. In the case of a heterogeneous product, PDEP is at best a weak measure of collusive behavior. At worst, PDEP may capture only quality differences. Furthermore, PDEP only represents pricing adjustments that can be used by insurers on an ex ante basis. Pricing adjustments can also occur through creative premium payment plans and through the granting of dividends.

The last of the dependent variables, the statewide Herfindahl index (HRF), is most straightforwardly measured. For each state, the sum of each workers' compensation insurer's squared market share is calculated. Market share is based on direct premiums written. If a given insurer had negative direct premium written (DPW) in a given year, then DPW was set equal to zero.

Recall that η, which appears in both the structure and performance equations, is difficult to measure for most industries and/or products, including private workers' compensation insurance. The proposed method to handle this problem is to replace η with variables assumed to affect elasticity. All states require employers to finance their workers' compensation obligation through private insurers, state funds (if available in a given state) or self-insurance (if it is permitted within the state and the employer qualifies). So price elasticity of demand for private insurance will depend on the relative cost and availability of the substitutes, namely state funds and self-insurance.

Cost measures for state funds are difficult to obtain. This is in part because the funds typically act as the residual market mechanism and do not keep separate data on employers who use the fund voluntarily versus those who use

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[9] This variable was not made available on a by-insurer basis. Generally, when an insurer files for a deviation, the deviation must be across-the-board for all policies. Schedule rating debits and credits, on the other hand, can be applied to individual employers. Because of the cancellation effect of averaging, large deviations by small insurers and large schedule rating debits and credits granted to small employers will, in effect, go unnoticed. For this reason, it is better to have data on a by-insurer basis. As previously noted, such data was unavailable for this study.

the fund because they could not get coverage elsewhere. Because of the difficulty in separating out the residual market component of the state fund, state fund data are not used in this study.

The extent to which self-insurance is utilized by employers captures its importance as a substitute for private insurance.[10] Therefore, self-insured losses paid as a proportion of total losses paid (SELFINS) will be used as an elasticity "proxy" variable.

Finally, on the demand side, industry-wide elasticity depends, in part, on the proportion of large employers within the state. Large employers not only have greater bargaining power with private insurers, enabling them access to a wider variety of premium payment plans, but they also are more likely to qualify for and take advantage of self-insurance. The more large employers in the market, then, the greater the price elasticity of demand. To account for this, BIGER, the percentage of firms in the state who employ a thousand or more employees, is included in the set of variables known to affect demand elasticity.

Addressed earlier was the need to incorporate entry and exit into Clarke and Davies's model, which assumes the number of firms in the market is exogenous. Entry and exit must be accounted for because of the potential for profit erosion and for changing the structure of the market. This could be done using a reduced form approach or by including an endogenous entry variable in the system of simultaneous equations. The latter approach, though appealing, entails some practical difficulty in defining and measuring entry. For instance, issues such as how to treat changes in ownership and mergers and acquisitions must be addressed. Measurement errors are likely to result, as they would with the proposed reduced form approach. Since both approaches involve measurement error problems, the reduced form approach was adopted to avoid the potential identification problems that may occur by adding yet another equation to the system.

Therefore, entry and exit are accounted for through their effects on the Herfindahl index. Naturally, entry of firms into the market will depend on the opportunity to make profits and the height of any entry barriers. It will be attractive for prospective entrants to get into a particular market if they see that industry profitability is high. Before a new insurer can do business in a given state, a license must be obtained from the state's insurance department—a process that may cause delays in entering the market.[11] In this model, then, the previous year's profitability (LAGPRFT), if favorable, will bring entry in the current year.

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[10] Self-insurance for single employers is permitted in all but two states while group self-insurance is permitted in over half the states.

[11] Some insurers wishing to enter the workers' compensation market may not face this time lag because they may already be licensed to sell this coverage. These insurers may represent a significant source of entry into the market, and the delays they face in entering may be shorter than for those who must go through the licensing process. However, even these existing firms are unlikely to be able to enter without any delay because of start-up costs related to hiring or training underwriters and distributing the product.

As part of the licensing requirements, prospective insurers must have a minimum specified amount of capital and/or surplus. These minimum capital and surplus requirements vary by state and may represent a legal entry barrier. Indeed, there is some evidence (Munch and Smallwood, 1980) for the property-liability insurance industry that capital requirements reduce the number of domestic firms writing insurance in a state. Assuming that Munch and Smallwood's results apply here, minimum capital and surplus requirements (CAPREQ), because they appear to present an entry barrier, should have an impact on the Herfindahl index.[12]

If economically significant costs are imposed on insurers to remain in a market, then exit from the market will be induced. In the case of workers' compensation insurance (as in other lines), insurers must bear their proportionate share of residual market losses in each state in which they operate.[13] A large residual market may impose an excessive financial burden on certain insurers, causing them to exit. Residual market share (RESSHR) will be used to account for this potentially exit-inducing effect on the Herfindahl index.

Since accurate insurer expense data are unavailable by line and by state, direct measurement of v_c^2 is impossible. However, as discussed previously, there is empirical evidence of an expense differential between direct writer and independent agency insurers. Thus, DWSHR will be used as a proxy for v_c^2.

The basic model was developed without regard to any regulatory constraints that might exist within the market. In the empirical testing of the model, such constraints must be accounted for since they are likely to have an effect on insurer conduct (and insurer conduct, according to the model, ultimately impacts on profitability). Rate regulation, depending on its restrictiveness, may limit pricing flexibility for insurers. The greater pricing flexibility that competitive rate regulation affords will have an impact on rate departures, depending on the level of the bureau's recommended rates. High rate levels will likely lead to downward departures, and low rate levels will lead to upward departures.

Although the precise impact of rate regulation on insurer behavior is difficult to predict, it must be taken into account. A rate regulation dummy variable (RTREG) is included as an independent variable in the conduct equation. This variable takes on a value of zero if there is restrictive rate regulation (prior approval or state-made rates) within the state and one otherwise. To further capture the degree of pricing flexibility allowed by rate regulation, a variable DEV, which takes a value of zero if rate deviations are not permitted within the state and one if permitted, is also included.

Finally, some indication of the degree of pricing flexibility afforded by state regulation can be found from the residual market share. Approved rates represent a price ceiling to insurers, and the height of that ceiling has an impact on the size of the residual market and on the percentage departure from bureau rates. A higher ceiling allows more pricing flexibility and leaves more room for

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[12] Sources for the variable CAPREQ are the National Association of Independent Insurers (1986) and telephone calls to state insurance departments.

[13] Occasionally, some states have a residual market gain. This is the exception, however.

downward departures (if permitted). If residual market share (RESSHR) is a reflection of how high a price ceiling regulated rates represent, then a lower residual market share (representing higher price ceilings) would lead to lower (or deeper downward) departures from bureau rates.

Because the degree of industrialization and industry mix vary by state, the risk that insurers face is likely to vary correspondingly. To control for the effects of risk on insurer profitability, a series of variables is used to represent the percent of the state's payroll in each one-digit Standard Industrial Classification category (excluding agriculture). These variables are denoted as PCTMIN, PCTMFG, PCTCON, PCTTRN, PCTWHL, PCTRET, PCTFIR, and PCTSER. The anticipated effect of industry risk exposure on profitability is not clear. If insurers are able to adequately price risk, then there should be no effect on profitability. However, if they cannot, profitability may be adversely affected. An inability to price risk adequately may arise because of constraints presented by restrictive rate regulation, lack of sufficient loss data, and possible information advantages on the part of employers.

Finally, to control for differences in statewide economic activity, UNEM, the statewide unemployment rate, is included in the performance equation. The state of the economy may influence benefit utilization. Moral hazard may induce workers to file claims or extend their disability spells when economic times are bad. On the other hand, in an economic upswing, employees may work longer hours and/or at a faster pace, making them more susceptible to injuries (Chelius, 1979). Table 1 summarizes selected variable names and presents summary statistics.

Equation Specification and Sampling Considerations

The previous discussion yields the following system of equations (representing the structure, conduct, and performance equations, respectively) to estimate:

HRF = f(PDEP, LAGPRFT, DWSHR, CAPREQ, SELFINS, BIGER, RESSHR),

PDEP = f(HRF, RTREG, RESSHR, DEV), and

PRFT = f(HRF, PDEP, SELFINS, BIGER, DWSHR, ITRATE, LEV, LEV_RATE, OLLR, UNEM, PCTMIN, PCTMFG, PCTCON, PCTTRN, PCTWHL, PCTRET, PCTFIR, PCTSER).

Since the collusion hypothesis says that concentration facilitates collusion and thus firms in highly concentrated industries will earn economic rents, a positive relationship between HRF and PDEP and PDEP and PRFT would be observed if this hypothesis holds.

The differential efficiency hypothesis says that firms with production advantages capture a larger share of output and thus are able to earn economic rents. If this hypothesis holds, a positive relationship between DWSHR and HRF is expected. Both hypotheses hinge on a positive relationship between HRF and PRFT. Furthermore, one hypothesis does not preclude the other.

The above set of equations was estimated using two-stage least squares on data that have been transformed around state specific means (i.e., fixed effects).

Table 1
Description of Variables

Variable	*Mean*	*Standard Deviation*	*Definition*
HRF	0.055	0.025	Sum of the squared market shares of each insurer in a state (based on direct premiums written). (Source: Best's Executive Data Service.)[a]
PDEP	-4.396	5.513	Statewide weighted-average percentage departure from standard earned premium due to rate deviations and schedule rating debits and/or credits. (Source: National Council on Compensation Insurance.)
PRFT	0.132	0.191	1 - $\frac{\text{Losses Incurred}}{\text{Direct Premiums Earned} - \text{Policyholder Dividends}}$. (Source: Best's Executive Data Service.)
SELFINS	7.317	4.252	Percentage of self-insured losses paid in relation to total losses paid. (Source: *Social Security Bulletin*, various issues.)
RESSHR	12.047	9.506	Residual market share. (Source: National Council on Compensation Insurance, 1986, 1987.)
RTREG	0.153	0.361	1 if competitive rate regulation (including file and use and use and file), 0 if restrictive rate regulation (prior approval or state-made rates). (Source: Risk Planning Group, 1982, and telephone calls to state insurance departments.)
OLLR	0.693	0.256	Ratio of losses incurred to premium earned for Other Liability. (Source: Best's Executive Data Service.)
LEV	6.774	2.908	The ratio of direct losses unpaid to direct losses incurred for workers' compensation. (Source: Best's Executive Data Service.)
DEV	0.616	0.488	1 if rate deviations are permitted, 0 if not. (Source: Risk Planning Group, 1982, and telephone calls to state insurance departments.)
DWSHR	0.225	0.070	Proportion of direct premiums written by direct writers. (Source: Best's Executive Data Service.)
BIGER	0.080	0.028	Proportion of employers with 1,000 or more employees. (Source: U.S. Census Bureau, *County Business Patterns*, various years.)
UNEM	7.592	2.481	Statewide unemployment rate. (Source: U.S. Census Bureau, *Statistical Abstracts of the United States*, various years.)
ITRATE	10.736	2.088	Intermediate-term government bond rate, measured using a one-bond portfolio with a maturity of five years. (Source: Ibbotson Associates, 1990.)
LEV_RATE	73.463	36.538	ITRATE x LEV. (Source: See ITRATE and LEV.)

[a] These data tapes are maintained by the S. S. Huebner Foundation, University of Pennsylvania.

Because of data limitations, only 29 states are represented in this sample: Alabama, Alaska, Arkansas, Connecticut, District of Columbia, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Michigan, Missouri, Nebraska, New Hampshire, New Mexico, North Carolina, Oregon, Rhode Island, South Carolina, South Dakota, Tennessee, Texas,

Vermont, Virginia, and Wisconsin. For the most part, states with state funds have been eliminated (the exceptions are Michigan and Oregon, which have competitive state funds). Excluding states with monopoly funds does not have an impact on this analysis since the aim is to investigate the structure and performance of the private workers' compensation market. However, to the extent that states with competitive state funds differ from other states, these results will not be generalizable.

The sample is otherwise reasonably representative of the workers' compensation market with respect to the sources of financing for workers' compensation losses. For instance, in 1987, total losses paid by private insurers in the 29 states in the sample represented approximately 57 percent of total losses paid by private insurers nationwide and 36 percent of total losses paid from all sources (competitive state funds, self-insurers and private insurers) except monopoly funds (*Social Security Bulletin,* 1991). In terms of volume of losses paid by private insurers five of the ten largest states (excluding monopoly fund states) are included in the sample (Texas, Illinois, Florida, Michigan, and Georgia). In addition, five of the ten largest states in terms of volume of losses paid by self insurers (excluding monopoly fund states) are included in the sample (Florida, Michigan, Illinois, Louisiana, and Connecticut).

Estimation Results

The estimation results are presented in Table 2. For each equation, the implications for the hypotheses tested are discussed.

The PRFT Equation

Interestingly, the positive relationship between profitability and concentration that both the collusion and differential efficiency hypotheses predict is not found here. Instead, the coefficient of the Herfindahl index is negative and statistically significant. However, since the Herfindahl index does not capture the proportion of insurers that write at bureau rates, this result may not be inconsistent with the collusion hypothesis. Furthermore, this negative relationship between concentration and profitability may not be inconsistent with the differential efficiency hypothesis either. Because profitability is measured simply as one minus the loss ratio, a negative relationship could be found if large insurers tend to operate with a lower expenses-to-premiums ratio. Alternatively, a negative sign may be observed if, due to vigorous competition among the top insurers, there is significant movement over time in their relative rankings. Such competition may drive down profits.

The positive sign on the coefficient for PDEP is consistent with the collusion hypothesis, however it is not significant at conventional levels. Of the elasticity variables (SELFINS and BIGER), the coefficient for SELFINS is insignificant. Self-insurance seems not to pose much of a threat to the profitability of private insurers. The coefficient for BIGER, however, is positive and significant, the opposite of what was expected. Rather than picking up demand elasticity,

Table 2
Two Stage Least Squares Results: Parameter Estimates

Independent Variable	*Dependent Variable*		
	PRFT[a]	*PDEP*	*HRF*
PRFT	---	---	---
PDEP	0.0097	---	0.374E-4
	(1.381)	---	(0.105)
HRF	-11.5901	-5.0961	---
	(-3.588)	(-0.187)	
SELFINS	0.0041	---	-0.0002
	(-0.469)		(-0.303)
BIGER	5.2120	---	0.2580
	(2.559)	(2.333)	
DWSHR	2.2951	---	0.1614
	(3.502)	(9.397)	
ITRATE	-0.0235	---	---
	(-1.273)		
LEV	0.0174	---	---
	(0.674)		
LEV_RATE	0.0044	---	---
	(1.810)		
UNEM	-0.0084	---	---
	(-0.865)		
OLLR	-0.1976	---	---
	(-3.383)		
RTREG	---	-11.4922	---
		(-9.327)	
RESSHR	---	0.1165	0.0005
		(2.905)	(3.824)
DEV	---	-3.4374	---
		(-4.792)	
CAPREQ	---	---	6.944E-9
			(3.425)
LAGPRFT	---	---	-0.0036
			(-0.575)
Adj. R^2	0.3583	0.3291	0.5135
F-Statistic	6.863	24.182	29.498

Note: T-statistics are in parentheses.
[a] In the PRFT equation, all coefficients for the industry mix variables were negative and insignificant.

BIGER may be picking up the higher service intensity received by large employers. In an effort to induce large employers to finance their workers' compensation obligation through insurance rather than self-insurance, insurers may have to offer these employers better service. The corresponding increase in insurer expenses would create a positive relationship between the profit

measure used in this study and BIGER, since PRFT = profit margin + expense ratio - investment income/premiums.[14]

The coefficient for the interest rate variable (ITRATE) has the predicted negative sign, but it is not significant at conventional levels. This may be due to the fact that ITRATE is the only variable that varies in the time-series but not in the cross-section, and as such it may be picking up time dependent factors that influence PRFT. By itself, LEV does not appear to have an affect on profitability, but when interacted with ITRATE, a more significant effect on profitability is observed. When high interest rates are combined with a relatively longer payout tail, insurer profitability increases.

The significant positive coefficient for DWSHR may be interpreted as evidence that direct writers are able to earn higher profits than their independent agency counterparts as a result of their expense advantage. The significant negative coefficient for the loss ratio for other liability (OLLR) indicates that good underwriting experience for this line is associated with higher profitability for workers' compensation. Finally, the results show no relationship between the unemployment rate and workers' compensation profitability.

The PDEP Equation

The results show a negative and insignificant coefficient between the percentage departure from bureau rates (PDEP) and the Herfindahl index (HRF). This result that is not consistent with the collusion hypothesis, but again the concentration measure does not take into account the proportion of insurers that adhere to bureau rates.

The negative and significant coefficients for RTREG and DEV imply that a more flexible regulatory environment is associated with deeper downward departures from bureau rates. In interpreting this result, however, it is important to remember that PDEP represents the departure from advisory rates for states with competitive rating and approved rates for states with restrictive rate regulation. Approved rates do not necessarily represent the rates that the bureau would like to have for its member insurers (presumably, the bureau would want rates that maximize joint profits); rather, approved rates may more likely represent those rates that the *regulators* want. Regulators may be subject to pressure from employers to keep rates low, which could explain why downward departures are smaller in prior approval states. Meanwhile, in competitive rating states the bureau's advisory rates would not have to reflect the aforementioned political pressure, and therefore could be relatively high, allowing insurers more room for downward departures.

The positive and significant coefficient for residual market share (RESSHR) is consistent with the proposition that approved rates (or advisory rates, in the

[14] Or, in the same vein, large employers may indeed be self-insuring, leaving the smaller employers to the private insurers. If insurers incur proportionately higher marketing expenses in writing the business of smaller employers, then there would be a positive relationship between BIGER and PRFT.

case of a state with competitive rating) represent a price ceiling. The higher that ceiling (which would mean a lower residual market share), the deeper the downward departures from bureau rates. Interestingly, during the sample period, the size of the residual market grew from 12.29 percent in 1980 to 20.63 percent in 1987, implying that price ceilings fell during that period. Falling price ceilings appear to be inconsistent with the weak evidence for collusion found in the PRFT equation. However, if product quality is taken into account, these observations perhaps can be reconciled. Insurers may be able to maintain their profitability despite lower price ceilings by providing less service to employers.

The HRF Equation

In the Herfindahl index (HRF) equation, the insignificant coefficient for PDEP is not consistent with the collusion hypothesis according to Clarke and Davies' model. Their model is somewhat unconventional, however, in that they assume collusion concentrates the market.

Direct writer share (DWSHR) has a positive and significant coefficient, supporting the differential efficiency hypothesis. The profit (PRFT) equation provides evidence that direct writers are also more profitable. Direct writing insurers, however, may pass on some of their lower costs to employers in the form of lower premiums. The extent to which they might do so is impossible to discern from the available data. But if direct writers earn economic rents, a steady expansion of their market share should be observed as they seek to increase their advantage. The lack of significant gains in market share by direct writers during the sample period might be taken as evidence that no rents were being earned. However, in the workers' compensation market, a large proportion of direct writers are organized as mutuals, which, during periods of underwriting crisis (which characterized much of the sample period), have an especially difficult time raising capital since they do not have access to the equity markets.

The negative coefficient on LAGPRFT indicates that last period's profits attract entry in the current period, but this result is not statistically significant. The other variable included to control for the effects of entry on concentration, CAPREQ, was positive and significant, suggesting that minimum capital and surplus requirements pose a significant barrier to entry. The variable used to control for exit, RESSHR, had a positive and significant coefficient. This implies that a large residual market does in fact induce exit, thereby increasing concentration.

Of the elasticity variables (SELFINS and BIGER), BIGER again showed an unexpected positive coefficient. A positive coefficient might be found if large employers choosing private insurance tend to insure with large insurers. Often small insurers specialize in certain types of risks and may not be able to meet the needs of a large employer. Finally, the insignificant coefficient on SELFINS suggests that self-insurance does not have much of an effect on the structure of the private workers' compensation market. This is interesting from a public policy standpoint because self-insurance does not appear to have a

significant effect on the profitability of the market either. Perhaps this is an indication that eligibility and security requirements for self-insurance are excessive.

The above results appear to dispel the collusion hypothesis. However, because these data cannot capture the proportion of insurers that write at bureau rates, the question of whether the bureau acts as a cartel remains unanswered. These results indicate that market concentration and collusion (as proxied by PDEP) are unrelated, but the degree of adherence to bureau rates and profitability may be related (the coefficient for PDEP in the PRFT equation is significant at about the 17 percent level). This suggests that it is the bureau that may facilitate collusion, not concentration. To explore this issue further, Danzon's (1983) testable predictions for bureaus as cartels were investigated (see pp. 374-375). Only two of the five predictions she proposed could be tested with the data used in this study: deviations from bureau rates will be downward, and adherence to bureau rates will greatest in prior approval states. Both of these predictions were borne out in the results of this study, but only on a statewide weighted average basis. The remaining three predictions proposed by Danzon require data showing which insurers were adhering to bureau rates and more specific information on bureau activities, none of which were available for this study.

Danzon also proposed testable predictions for bureaus as providers of services for which there are economies of scale. Again, not all of these could be tested with the data from this study. One of the predictions that could be tested is that deviations from bureau rates may be upward or downward. The data in this study show that average statewide deviations are almost universally downward, which tends to support the notion of the bureau as a cartel (if there is product homogeneity). But disaggregated data on the *number* of insurers filing upward or downward deviations would be more revealing. Interestingly, the other testable prediction for the "service model" of bureaus, which is supported by this study's results, is the same as one of the predictions for the "cartel model": adherence to bureau rates will be greater in prior approval states. This adherence is predicted in the "cartel model" because restrictive rate regulation makes it more costly to deviate. This same prediction arises in the "service model" because one of the services the bureau performs is dealing with the regulators. This study gives weak support for the bureau as a cartel.

Conclusions

Studying the impact of market structure on the pricing behavior of firms is especially important in the private workers' compensation market since workers' compensation has some of the characteristics of a social insurance program. No comprehensive study examining the structure and performance of the private workers' compensation insurance market has been undertaken; this study attempts to fill that gap.

Neither of the two central hypotheses offered by the industrial organization literature to explain the relationship between industry structure and industry

profitability are fully supported by the results found here. The positive relationship between concentration and profitability predicted by these hypotheses was not observed. Evidence that the lower cost direct writers capture a larger share of output provides partial support for the differential efficiency hypothesis, though it cannot be determined whether these insurers are earning economic rents because of the difficulty of precisely measuring profitability on a by-line by-state basis. The positive relationship between collusion (proxied by the statewide weighted-average percent departure from bureau rates) and profitability predicted by the collusion hypothesis was found (though it was not highly significant), which showed that in states where departures were smaller, industry profitability was higher. However, whether the bureau fosters cartel behavior cannot be discerned without more detailed data on insurers' rate departures.

The lack of conclusive evidence of collusion for this line may be useful in the recurring debate on the repeal of the McCarran-Ferguson Act. This debate is in part stimulated by the concern that rating bureaus might facilitate anti-competitive behavior. Arguably, this potential for cartel behavior may be the strongest for workers' compensation since adherence to bureau rates is required in a number of states. Further research using data on the number of insurers departing from bureau rates would be required to fully explore the collusion hypothesis. If many insurers are departing from bureau rates, that would indicate an ineffective cartel and lack of collusion, in which case one of the chief arguments for the repeal of the Act would be groundless.

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