

The Relationship Between Voluntary and Involuntary Market Rates and Rate Regulation in Automobile Insurance

Scott E. Harrington

Abstract

A multiple regression model is estimated with cross-state data to provide evidence of the impact of voluntary market rate regulation and involuntary market "deficits" on the overall ratio of premiums to losses in the private passenger auto insurance market from 1979 through 1981. The results provide evidence that voluntary market rate regulation reduced the ratio of premiums to losses for the overall market. They also suggest that voluntary market rate regulation reduced voluntary market premiums in states with small involuntary market deficits, but that large deficits were likely to have increased voluntary market premiums above levels that would have existed in an unregulated market in the absence of any deficit.

Introduction

Cross-subsidization from low-cost to high-cost consumers often has occurred in industries subject to price regulation when production costs differ across consumers.¹ The potential for increased political support from engaging in cross-subsidization may help to explain the existence of price regulation in competitively structured industries, especially when nonprice competition is likely to impede the use of price regulation to achieve profits for producers. A possible example is the competitively structured market for private passenger auto insurance, which has long been subject to a two-tiered system of rate regulation. Joskow (1973) suggested a producer protection motive for auto insurance rate regulation (also see Ippolito, 1979). While this motive probably has some historical validity, empirical evidence suggests that rate regulation on average has decreased the ratio of premiums to losses in private passenger auto insurance during the 1970s and early 1980s (Grabowski, Viscusi and Evans, 1989, Harrington, 1984a and 1987, and

Scott E. Harrington is Professor of Insurance and Finance at the University of South Carolina. He wishes to thank the referees for their helpful comments.

¹ See Keeler (1984) for discussion of this phenomenon in the airline, railroad, and telecommunications industries. Also see Wenders (1986).

Pauly, Kleindorfer, and Kunreuther, 1986; also see U.S. General Accounting Office, 1986).²

The overall market for auto insurance has two components: the voluntary market, in which firms willingly contract with consumers, and the involuntary (residual) market, in which insurers are forced to issue contracts to certain persons. Voluntary market rates are regulated in about half of the states; involuntary market rates are regulated in all states.³ In principle, involuntary markets may be needed as a result of adverse selection, which conceivably could prevent a viable voluntary market for certain consumers. Whether unregulated markets could fail in some instances due to a "lemons" phenomenon that could not be overcome by price and quantity competition (e.g., Rothschild and Stiglitz, 1976) is uncertain. However, it is unlikely that adverse selection can explain the substantial size of the involuntary market in a number of states. A more likely explanation is that involuntary market rate regulation produces rate levels that essentially crowd out the voluntary market for some consumers (Mintel, 1983). Involuntary market rate regulation enables regulators to reduce rates for certain consumers. Mandatory pooling ensures that any adverse financial results are spread broadly among companies.

The relationship between voluntary and involuntary market rates and rate regulation in auto insurance and, more generally, the property-liability insurance industry has received little attention in the literature. The fact that auto insurance involuntary markets in some states consistently produce substantial accounting losses is well known (see Lee, 1977, Mintel, 1983, and Grabowski, Viscusi, and Evans, 1989). Little is known about the extent to which voluntary market rates are affected by involuntary market results, or whether voluntary market rate regulation affects the relationship between involuntary market results and voluntary market premiums. Previous studies of the impact of voluntary market rate regulation have focused exclusively on

²Harrington (1984b) surveys the earlier literature on this subject. Unless otherwise noted "auto insurance" will refer to "private passenger auto insurance" throughout the remainder of the article.

³The term "voluntary market rate regulation" is used to denote all forms of prior approval regulation, including state made rates. Rates in states with competitive rating laws often will be referred to as "unregulated." There are four broad types of involuntary markets. Over 40 states have assigned risk plans in which involuntary market insureds are assigned to insurers in proportion to their voluntary market share. A few states use a select number of insurers to write policies for the involuntary market with the financial results spread among all insurers in proportion to voluntary market volume. A few others require insurers to accept all applicants at regulated rates but allow insurers to reinsure unwanted business in a state pool with the results of the pool again spread among all insurers. In these states, voluntary and involuntary market rate regulation essentially are merged with the relative adequacy of rates in particular rating classes determining which risks will be reinsured. Maryland has a state insurer for involuntary market risks. Its accounting losses are assessed against private insurers in proportion to market share. For further details, see Lee (1977).

the relationship between aggregate premiums and losses for the total market (i.e., for the voluntary and involuntary market combined).⁴

This study analyzes the relationship between voluntary and involuntary market rates and rate regulation. A multiple regression model is estimated with cross-state data to provide evidence of the impact of voluntary market rate regulation and a measure of involuntary market deficits (defined below) on the overall ratio of premiums to losses in the private passenger auto insurance market from 1979 through 1981. As in previous work, the results suggest that voluntary market rate regulation reduced the ratio of premiums to losses for the overall market. They also suggest that voluntary market rate regulation reduced voluntary market premiums in states with small involuntary market deficits. However, they suggest that large deficits were likely to have produced considerably higher voluntary market premiums than would have occurred without any deficit in an unregulated market.

The following section describes the relationship between economic losses in the involuntary market and voluntary market premiums that would be likely to exist in a competitive market, first when voluntary market rates are unregulated and then when they are regulated. Definitional issues that arise in the presence of economies of scale and scope in insurance production also are discussed. Next, a simple model of rate regulation is developed to provide the basis for the empirical work. The deficit measure, econometric model, and data used are then described. Empirical results are presented, followed by conclusions and suggestions for additional work.

Involuntary Market Experience and Voluntary Market Rates

If a state's involuntary market persistently experiences a sizable accounting (operating) loss, it commonly is believed that voluntary market rates will increase so that insurers will not experience economic losses for the overall market (e.g., Lee, 1977, and Mintel, 1983). Particular definitions of accounting losses aside, if involuntary market rates for certain groups are set below levels that would exist without regulation, product quality for the business would tend to decline if insurers were able (for example) to save money by reducing services or to increase income by slowing down claim payments without increasing the ultimate cost of claims.⁵ In the absence of voluntary market rate regulation, a persistent and thus expected economic loss for the involuntary market (i.e., any excess in the discounted value of claim and all other costs over premiums) that remained after any changes in quality would tend to increase premiums (and perhaps affect quality) in the voluntary market. The process would be analogous to the standard model of a

⁴Harrington (1987) provided evidence that the impact of voluntary market rate regulation varied across states. The causes of the variation were not considered.

⁵These opportunities may be limited for third-party liability coverage. It also should be noted that joint underwriting associations and reinsurance facilities may dilute insurer incentives to control claim costs.

competitive industry (in this case, the voluntary market) subject to a per unit or ad valorem tax, since writing a policy voluntarily would increase an insurer's share of the expected economic loss for the involuntary market.

Voluntary market rate regulation could interfere with this process and reduce average rates for the overall market. Large involuntary market accounting losses occur almost exclusively in states that regulate voluntary market rates. If an economic loss were expected for the involuntary market, regulation of voluntary market rates would allow regulators to affect the incidence of the increase in voluntary market premiums that would be needed for insurers to break even for the overall market absent changes in quality in the voluntary market. If voluntary market rate regulation did not allow premiums to increase enough to offset any expected economic loss for the involuntary market, product quality in the voluntary market would tend to decline. Another possible response to restrictive voluntary market rate regulation would be for the supply of coverage to contract in the voluntary market. If this caused certain groups of insureds for which involuntary market rates exceeded voluntary market rates to be denied coverage, the size of the involuntary market would increase, and the expected economic loss for the involuntary market could decrease if the involuntary market premium rate exceeded the discounted value of all costs for such groups.

Absent economies of scale or scope, any premium inadequacy for the overall auto insurance market in a given state (relative to the level of premiums that would exist in the absence of regulation) that could not be offset by changes in quality would produce economic losses for insurers. Persistent premium inadequacy would cause insurers to exit from the market. On the other hand, it is possible that common costs and thus economies of scope exist in the production and distribution of auto insurance and other types of coverage. If so, reductions in total auto insurance premiums below the level that would exist without rate regulation might lead to higher premiums in other lines without attracting entry by issuers who specialized in such lines without writing auto coverage.

Similarly, it occasionally has been argued that insurers may be able to offset inadequate rates in one state by charging higher premiums in other states. At a minimum, increasing returns to scale for nationwide sales of auto coverage would be needed in order for this to occur. Otherwise, regional insurers that did not write coverage in states with restrictive rate regulation would be able to charge lower premiums than national insurers who attempted to pursue such strategies.⁶

Almost nothing is known about whether these effects actually occur. If, however, increasing returns to scale or economies of scope exist, the concept of economic loss (or subsidy) in either the involuntary market or the overall

⁶Moreover, if national insurers had sufficient market power to export losses from state A to state B, the question would arise as to why they were not charging higher premiums in state B to begin with.

auto insurance market in a given state would not be well-defined. These concepts have a clear meaning only in the case of cost additivity. If instead costs are sub-additive, it is not possible to calculate total costs for a given type of coverage or subset of insureds, and the measurement of any economic loss (an excess of premiums over costs) is problematic.

A number of econometric studies of insurer cost functions have provided evidence of increasing returns to scale in the property-liability insurance industry (see, for example, Cummins and Van Derhei, 1979). These studies employed aggregate data for the industry; product specific returns to scale for auto insurance were not estimated. Moreover, this type of research may be subject to a bias towards finding increasing returns to scale. Information on average account size is not available, and large insurers are likely to have larger average size accounts (which have lower expense ratios) in commercial lines than are small insurers. Lee (1989) estimated economies of scale and scope for direct writers of auto insurance, homeowners insurance, and other lines combined. His results are largely consistent with constant returns to scale for auto insurance and an absence of scope economies. A number of other factors, such as the lack of high market concentration (especially at the national level), and the existence of numerous small regional companies that specialize in auto insurance, also are difficult to reconcile with substantial economies of scale and scope.

Subsequent discussion in this article essentially assumes that the auto insurance market is competitive and that it is possible to talk meaningfully about total costs for either the voluntary or involuntary market. The framework used does not formally consider scope and scale economies. These assumptions are not critical. What is essential is that it makes sense to talk about premium levels that would exist for subgroups of insureds in the absence of rate regulation. Important measurement issues also arise concerning the key variable used in the empirical work. The implication of errors in measurement for the analysis will be discussed where appropriate.

Empirical Framework

The basic objective of the empirical work is to estimate the extent to which a reduction in involuntary market premiums below the level that would have existed for the same insureds in the absence of rate regulation led to an increase in voluntary market premiums above the level that would have existed for the same insureds in the absence of rate regulation. The term "deficit" is used to denote any such shortfall in involuntary market premiums. As noted previously and discussed further below, this deficit will exceed the economic loss in the involuntary market if cost-saving (or income-increasing) reductions in quality occur in response to low involuntary market rates.

The level of premiums that would exist in either the voluntary or involuntary market without involuntary market rate regulation is unobservable. Using published data, it is also impossible to calculate an accurate loss ratio for the

voluntary market.⁷ The methodology is designed in view of the information that is available: data on aggregate market earned premiums and calendar-year incurred losses and information on "target" loss ratios (developed by the industry) and underwriting results for the involuntary market.⁸

Consider a simple model in which the aggregate premium needed for insurers to break even in any given market is proportional to aggregate expected losses for coverage written, i.e., $P = \lambda L$ where P equals break even premiums, λ is the proportionate "loading" factor, and L equals expected losses. In general, λ will depend on sales and loss adjustment expenses, on interest rates and the timing of claim payments, and on other insurer costs including taxes and the cost of capital. Assume initially that insurers cannot alter λ by changing product quality.

Let P_V and L_V equal premiums and expected losses in the voluntary market, P_I and L_I equal premiums and expected losses in the involuntary market, and P_T and L_T equal total market premiums ($P_V + P_I$) and losses ($L_V + L_I$), respectively. Assume that L_V and L_I and thus L_T are fixed. Total premiums can be expressed as:

$$P_T = \lambda(L_V + L_I) + (P_V - \lambda L_V) - (\lambda L_I - P_I) \quad (1)$$

The first term in this expression equals break even premiums for the total market. The second term is any excess of actual premiums over break even premiums for the voluntary market. The third term is the deficit in the involuntary market (i.e., the excess of break even premiums over actual premiums), which will be denoted by D .

Assume further that voluntary market premiums are given by:

$$P_V = \lambda L_V + \delta D \quad (2)$$

where δ is the proportion of the deficit that is shifted to the voluntary market. Substituting (2) into (1) and dividing by L_T gives:

$$P_T/L_T = \lambda + (\delta - 1)D/L_T \quad (3)$$

If $\delta = 1$, as would be expected under these assumptions if the voluntary market were competitive, the ratio of premiums to losses for the aggregate market would be invariant to the amount of deficit. If $\delta < 1$, the ratio of premiums to losses for the aggregate market is negatively related to the deficit.

⁷ *Best's Executive Data Service* reports calendar-year incurred losses and earned premiums for the overall market. Until the early 1980s, *AIPSO Facts* reported voluntary market premiums and losses for liability coverage, but only for states with assigned risk plans. Moreover, accident-year losses are reported for most states in this source, and they include loss adjustment expenses, whereas the *Best* calendar-year data exclude all loss adjustment costs.

⁸ The empirical model analyzes the ratio of earned premiums to calendar-year incurred losses (the inverse of the loss ratio) for the aggregate market. Previous empirical analyses generally have analyzed the loss ratio or its inverse. The use of its inverse in this study allowed estimation with a linear model.

Equation (3) suggests that, given suitable cross-section data, an estimate of δ could be obtained by regressing P_T/L_T on D/L_T and variables that could be related to cross-state differences in λ . The estimated coefficient for D/L_T would provide an estimate of $\delta - 1$, adding one to this estimate would yield an estimate of δ . Under these assumptions, an estimate of δ that is less than one would imply less than full recoupment of the involuntary market deficit in the form of higher voluntary market premiums.

Given the assumption that insurers cannot alter quality and thus λ , equations (1), (2), and (3) imply that insurers would fail to break even on the entire market if $\delta < 1$; i.e., $\delta < 1$ implies that $P_T < \lambda(L_V + L_I)$. However, if insurers can alter quality and thus costs, changes in quality in either the voluntary or involuntary market or both markets could allow total premiums to equal total expected costs even if $\delta < 1$. Specifically, if voluntary market premiums were determined by equation (2), insurers would break even with $\delta < 1$ provided that:⁹

$$(1 - \delta)D = L_V(\lambda - \lambda_V) + L_I(\lambda - \lambda_I) \quad (4)$$

where $\lambda_V (\leq \lambda)$ and $\lambda_I (\leq \lambda)$ represent loading factors needed to cover all costs (and reflect investment income) in the voluntary and involuntary markets, respectively, after any adjustments in quality are made. The left-hand-side of equation (4) is the amount of the aggregate deficit that would occur in the combined market if quality were not changed. The terms on the right side represent the reduction in costs in each market that would eliminate the aggregate deficit. If feasible reductions in quality were insufficient to eliminate the deficit, an economic loss would occur for the overall market.

Given the possibility of changes in quality, an estimate of δ from the suggested regression procedure that is less than one would be consistent with the failure of voluntary market premiums to increase by an amount equal to $D = \lambda L_I - P_I$. It would imply reductions in product quality, an economic loss for the combined market, or both.¹⁰

The development of equations (1), (2), and (3) also assumed that λ was the same for all business. This assumption is not crucial to the analysis. If λ were allowed to vary across drivers, equation (3) would hold with two differences. First, the λ that constitutes the first term on the right side would need to be replaced by the weighted-average value of λ for the aggregate market (with weights equal to L_i/L_T where L_i is the total expected loss for type i drivers). Second, the involuntary market deficit would need to be defined using the weighted-average value of λ for the drivers insured in the involuntary market

⁹As before, this equation treats L_V and L_I as fixed. If adjustments in quality reduced demand for coverage, greater changes in quality would be necessary for insurers to break-even for any given $\delta < 1$. L_V also could change if reductions in involuntary market premiums reduced the number of uninsured motorists and thus reduced voluntary market losses and premiums for uninsured motorists covered (see Keeton and Kwerel, 1984). It would be very difficult to sort out this type of effect with available data.

¹⁰Even if the deficit could be defined in terms of λ_I , i.e., $D' = \lambda_I L_I - P_I$, it would not be possible to sort out these influences unless λ_V also were known.

(with weights equal to L_{ij}/L_i where L_{ij} is the total expected loss for drivers of type i in the involuntary market).

Equations (2) and (3) do not allow regulation of voluntary market rates to affect voluntary market premiums if there is no deficit for the involuntary market. An empirically tractable modification to equation (3) that allows for this possibility is given by:

$$P_T/L_T = \lambda - \alpha + (\delta - 1)D/L_T, \quad (5)$$

which implies

$$P_V = (\lambda - \alpha)L_V + \delta D - \alpha L_I. \quad (6)$$

From (6), voluntary market premiums (and P_V/L_V) are increasing in δ and D and decreasing in α . If $\delta = 1$ and $\alpha > 0$, equation (6) implies that voluntary premiums equal $(\lambda - \alpha)L_V$ plus the excess of $(\lambda - \alpha)L_I$ over P_I . That is, rate regulation reduces the voluntary market premium loading by α , but voluntary market premiums increase by the involuntary market deficit defined using the same premium loading as for the voluntary market. If $\delta < 1$, voluntary market premiums increase by less than this amount.

If $D > 0$, voluntary market premiums exceed λL_V (break even premiums in the absence of regulation) if $\delta > \alpha L_T/D$, and the net increase in voluntary premiums $(P_V - \lambda L_V)$ as a proportion of the deficit $(\lambda L_I - P_I)$ is given by:

$$\theta = \delta - \alpha L_T/D \quad (7)$$

with (for $\alpha > 0$):

$$\frac{\partial \theta}{\partial \delta} > 0, \quad \frac{\partial \theta}{\partial \alpha} < 0, \quad \frac{\partial \theta}{\partial D} > 0, \quad \frac{\partial^2 \theta}{\partial D^2} < 0.$$

A value of θ less than one would be consistent with reductions in quality, an aggregate economic loss for insurers, or both. If $\alpha > 0$, $\theta < 1$ even if $\delta = 1$ (i.e., reductions in aggregate premiums imply either reductions in quality, an aggregate economic loss for insurers, or both).

Econometric Model and Data

As noted by Grabowski, Viscusi, and Evans (1985) (and shown later in this article), substantive involuntary market accounting losses are almost exclusively found in states that regulate voluntary market rates. Assuming that $D = 0$ or, alternatively, that $\delta = 1$ for states that have competitive rating for voluntary market rates (for which $\alpha = 0$) suggests the following model for the ratio of aggregate premiums to losses in regulated and unregulated states:

$$(P/L)_j = \gamma'Z_j - \alpha \text{REG}_j + (\delta - 1)\text{REG}_j \times (D/L)_j + \epsilon_j \quad (8)$$

where for state j , $(P/L)_j$ is the ratio of earned premiums to calendar-year incurred losses for the voluntary and involuntary market combined; Z_j is a vector of state characteristics that affect λ_j , the (weighted-average) premium loading factor that would occur without regulation; γ is a vector of parameters; REG_j equals 1 if voluntary market rates are regulated, 0

otherwise; $(D/L)_j$ is a measure of the involuntary market deficit divided by total calendar-year incurred losses for the voluntary and involuntary market (see below), and ϵ_j is a disturbance. This formulation is essentially equivalent to that used in prior studies of the impact of rate regulation on loss ratios or inverse loss ratios, with the exception that the mean impact of regulation is allowed to depend on the involuntary market deficit measure, as opposed to being fixed across states.

The definition of the deficit used in the development of the model is $(D/L)_j = D/L_T = (\lambda L_1 - P_1)/L_T$. The use of this definition in practice is plagued by a number of difficulties.¹¹ First, λ_1 , L_1 , and L_T are not directly observable. In this study, λ_1 is the inverse of the target loss ratio for the involuntary market that would produce zero underwriting profits according to the Automobile Insurance Plans Service Office (*AIPSO Facts*, 1983), the official industry ratemaking organization for the involuntary market in states with assigned risk plans. These targets assume that all investment income is needed to cover income tax costs, the cost of capital, and any other costs not included in underwriting expenses. For liability and related coverages, .05 was added to the target loss ratio to be consistent with nationwide underwriting results for the overall market during the period analyzed.¹² For physical damage coverages, the use of the AIPSO ratios without adjustment was consistent with nationwide results.¹³ For the nine states with alternative types of involuntary market mechanisms during the period analyzed, AIPSO did not publish comparable estimates. The average value of the target-ratios for the assigned risk plan states was used for these states.¹⁴

Reported calendar-year incurred losses for the total market were used for L_T . These data, which were obtained from *Best's Executive Data Service*, do not include loss adjustment expenses. Estimates of incurred losses for the involuntary market were obtained or developed from information in *AIPSO Facts*. Accident-year loss data were reported for states with assigned risk plans; calendar-year loss data were reported for the states with alternative mechanisms. The target loss ratios and reported accident-year incurred losses for the assigned risk plan states both reflect loss adjustment expenses. Since

¹¹ An alternative, which also would be subject to these problems, and require a different interpretation, would be to define the deficit as $1/L_T$ times the difference between actual involuntary market losses and the product of involuntary market premiums and the target loss ratio, where the target loss ratio equals $1/\lambda_1$. *AIPSO Facts* publishes deficit estimates of this type (also see Lee, 1977). Grabowski, Viscusi, and Evans (1989) used the AIPSO measure. Given the same data, the two measures would be very highly correlated.

¹² Related coverages include personal injury protection, medical payments, and uninsured motorists coverage. Disaggregated results for these lines and third-party liability coverage are not available. The term "liability" will be used to refer to the aggregate of these coverages throughout the remainder of the article.

¹³ Physical damage coverages primarily include collision, theft and other miscellaneous types of vehicle damage.

¹⁴ The ranges of the ratios for liability and physical damage coverages were .692-.772 and .731-.771, respectively. No data on involuntary market premiums and losses were available for Texas, which was excluded from the analysis.

the results for the alternative plan states were reported net of loss adjustment expenses, the net values were grossed up using national averages of the ratio of adjustment expenses to incurred losses.¹⁵ The incurred loss data for both markets will differ from expected accident-year losses due to random variation in accident-year losses. Revisions in reserves for losses in prior accident years will affect total incurred losses for all states and involuntary market incurred losses in states with alternative mechanisms.

Given these data limitations, the deficit measure will contain a certain amount of noise. An instrumental variable procedure described below is used to control for the influence of random noise. The possibility also exists that the deficit measure could systematically overstate (or understate) the value that would be obtained if the true weighted-average value of λ for the involuntary market were to be known. If, for example, the target loss ratios (including the .05 adjustment for liability described previously) failed to fully incorporate the economic value of investment income or overstated break-even underwriting expenses or other costs, the deficit measure would be biased upwards.¹⁶ Other things being equal, an upward bias in the deficit measure would tend to bias the estimate of $\delta - 1$ towards zero. As a result, the estimate of δ would tend to be biased towards one, and the bias would make rejection of the null hypothesis that $\delta = 1$ less likely.

The vector Z used to estimate equation (8) consisted of four variables (plus a constant term) for the liability equations: LOSS, WAGE, PIP, and THRESH. LOSS is the predicted value of the average liability loss per exposure from a regression of this variable on a number of demographic and economic characteristics that should effect interstate differences in the expected liability loss per exposure.¹⁷ It is used as an instrumental variable for the expected loss per exposure, which should be negatively related to the ratio of premiums to losses if underwriting and sales costs per policy increase at a

¹⁵ Ideally, accident-year losses would have been used for L_T and to calculate the deficit for each state. It also was necessary to estimate incurred losses for the alternative plan states assuming an equal expense ratio for private passenger and commercial business due to the vagaries of reported accounting data for these states. This treatment is unlikely to substantively influence the calculated deficit measures given the predominance of private passenger business in the involuntary market. Finally, Maryland's state insurer did not report losses separately for liability and physical damage coverages. Incurred losses for each line were estimated using the overall loss ratio and premiums for each line.

¹⁶ The target loss ratios are based on actual commission rates for the involuntary market. In some states these rates may be less than those in the voluntary market. Other things being equal, this difference would cause the calculated deficit to be less than the definition employed in developing the model and more closely related to the economic deficit. Venezian (1984) also has suggested that insurers may be biased towards assigning fault to involuntary market drivers when the question of fault is uncertain. Any such bias could cause incurred losses for the involuntary market and the deficit measure to be overstated. However, it is not clear whether this type of bias would be consistent with cost minimizing claims settlement by insurers.

¹⁷ The regressors included measures of household income, population density per road mile, proportion of population aged 16-24, alcohol consumption, urbanization of the population, hospital costs, and the availability of mass transportation. The $\bar{R}^2$ for both the liability loss and the combined liability and physical damage loss equations exceeded .70.

less than proportionate rate with the expected loss. It is used instead of the average loss per exposure because the latter variable could include considerable noise due to fluctuations in losses that could lead to spurious correlation with the ratio of premiums to losses. The use of this procedure, which was employed by Harrington (1987), may help to provide better estimates of the impact of rate regulation than those obtained in previous studies that ignored its influence or used a proxy variable such as urbanization of the state's population (e.g., Pauly, Kunreuther, and Kleindorfer, 1986).¹⁸

WAGE is the average hourly wage rate for production workers. If interstate differences in wage rates positively affect underwriting and sales costs relative to expected losses, WAGE should be positively related to the ratio of premiums to losses (see Pauly, Kunreuther, and Kleindorfer, 1986, and Harrington, 1987). PIP is personal injury protection premiums for states with no-fault and add-on laws as a proportion of total liability premiums. No-fault legislation is likely to be related to unanticipated growth in losses. The break even premium loading for PIP coverage also will tend to differ from that for liability coverage due to differences in loss adjustment costs and in the speed of claims payment. The estimated coefficient for PIP will reflect the combined effects of these influences. Previous work (Harrington, 1984a and 1987; also see Witt and Urrutia, 1983) suggests a sizable positive impact of PIP on the ratio of losses to premiums. As a result, PIP is likely to be negatively related to the ratio of premiums to losses. THRESH equals one for states with no-fault laws with a verbal tort threshold or a monetary threshold greater than or equal to \$1,000 and zero otherwise. It is included primarily to allow for the possibility of lower unanticipated growth in losses in states with thresholds that may effect a substantive reduction in lawsuits. If so, it should be positively related to the ratio of premiums to losses, although THRESH also could be related to differences in loss adjustment costs and the speed of claims payment.

As noted, the deficit measure may contain considerable noise that could be correlated with noise in the ratio of premiums to losses that arises from the use of incurred rather than expected losses. This measurement error would tend to bias the estimate of $\delta - 1$ towards zero if OLS were used to estimate equation (8). To mitigate this problem, the predicted value from a regression of $(D/L)_i$ on the involuntary market share of liability insurance written car-years was used as an instrumental variable for $(D/L)_i$. The value of $\bar{R}^2$ from this regression exceeded .90 for liability coverage and for liability and physical damage coverage combined. These high correlations suggest that the predicted values should be excellent instruments. A possible limitation of this procedure is that the involuntary market share might be correlated with unobservable factors that affect the disturbance in equation (8). For example, any cross-sectional variation in the "tightness" of rate regulation that is not picked

¹⁸ If voluntary market rate regulation tends to be more prevalent in high loss states, the failure to adequately control for the possible negative relationship between average expected loss and (P/L) could lead to a spurious negative association between rate regulation and (P/L) .

up by the explanatory variables could influence both ϵ and involuntary market share. If so, the estimate of $\delta - 1$ would tend to be biased downwards (the estimate of δ would be biased towards zero). However, if the prior approval dummy and the involuntary market deficit measure capture much of the influence of regulation on the ratio of premiums to losses, the resultant bias will be minor. Moreover, this type of bias would tend to offset the bias that could arise if the deficit measure overstates the difference between break-even and actual premiums for risks in the involuntary market.

As is shown below, some states with large calculated deficits for liability coverage also have sizeable deficits for physical damage coverage. Estimation of equation (8) using data for liability and physical damage coverage combined in addition to using data for liability insurance only will provide evidence of the extent that the aggregate deficit for the two types of coverage results in higher aggregate premiums for the voluntary market. It also has been suggested that liability insurance rates are subject to greater political pressure than are physical damage rates (e.g., Smallwood, 1975). If so, it is possible that the estimate of δ could be greater and that the estimate of α could be lower (if $\alpha > 0$) using combined data.

The regression equation for liability and physical damage insurance combined also included the ratio of incurred losses for liability coverage to incurred losses for liability and physical damage combined (LIAB), to control for the possible influence of product mix on the ratio of premiums to losses. The interaction of THRESH and LIAB was used instead of THRESH. LOSS was the predicted value of the average liability and physical damage loss per liability exposure from a regression of this variable on the economic and demographic variables described above. The predicted value of $(D/L)_i$ was obtained from a regression of the combined deficit measure for liability and physical damage on involuntary market share.¹⁹

Empirical Results

Table 1 shows averages of the involuntary market deficit measure for liability coverage, physical damage coverage, and liability and physical damage combined from 1979 through 1981 for the ten states with the highest deficit measure for liability coverage. The average involuntary market share of liability written car-years, and, for liability coverage, the ratio of the average premium for the involuntary market to that for the total market also are

¹⁹ A number of studies of the impact of rate regulation have estimated separate models for direct writers and independent agency insurers, generally with similar results. Since the deficit measure was available only for the aggregate market, separate estimation was not used in this study. Instead, the equations also were estimated with an instrumental variable for direct writer market share to control for the potential influence of direct writer share on the ratio of premiums to losses. This variable was superfluous and was omitted from the model. The instrument was obtained from a regression of average direct writer share during the period on the group of demographic and economic variables and direct writer share in 1969. The instrumental variable procedure was used given that direct writer share could be endogenous, i.e., it could depend on the ratio of premiums to losses for the voluntary and involuntary market.

shown.²⁰ Summary information concerning the variables also is shown in Table 1 for the remaining states that regulate voluntary market rates and for states with competitive rating laws.

Each of the ten states with the largest deficits for liability coverage also regulated voluntary market rates during this time (also see Grabowski, Viscusi, and Evans, 1989). This result raises the question of whether large deficits are politically viable unless voluntary market rate levels also are controlled by regulation. As would be expected, the deficit measure is highly correlated with involuntary market share. The ratio of the average premium in the involuntary market to the average premium for the total market provides rough evidence that rate "leveling" tended to occur in states with high deficits. While this ratio would be influenced by differences in average policy limits in the voluntary and involuntary markets, if the effect of rate regulation on involuntary market rates was small, a preponderance of risks with higher than average risk in the involuntary market would tend to cause the ratio to exceed one, perhaps substantially. As the deficit increases the ratio could be expected to decline both because of the direct effect of involuntary market rate regulation on premiums and the inclusion of an increasing number of drivers with lower expected accident costs in the involuntary market.

The results of estimating equation (8) using OLS (and the predicted values of the average loss and deficit variables) are shown in Tables 2 and 3.²¹ Results are shown for equations with and without the deficit variable. They are also shown for equations with and without the threshold variable, since this variable has not been employed in prior work and its inclusion had some effect on the results for the rate regulation variables. The estimates for LOSS and PIP have the anticipated signs and are highly significant for each equation shown. The estimates for the threshold variables are positive as expected.²²

²⁰The latter ratio was calculated using the average of liability written car-years for years t and $t - 1$ reported in *AIPSO Facts* to approximate earned exposures for year t . Earned premiums for the involuntary market were also obtained from this source. The average of written premiums for the total market in years t and $t - 1$ reported in *Best's* was used to approximate earned premiums for the total market. A number of states, including North Carolina, do not offer physical damage coverage in the involuntary market.

²¹Based on a number of regression diagnostics, Alaska appeared to be an outlier and was excluded from the sample. Its inclusion primarily affected the coefficient for WAGE. Harrington (1987) provided evidence that the disturbances in this type of model are likely to be heteroscedastic, primarily due to random variation in some of the parameters. Since the implications of his results were similar using OLS and maximum-likelihood estimation of a random coefficient model, the simpler OLS procedure is used here. If anything, his maximum-likelihood results suggested that the absolute OLS t -values were biased downwards.

²²While negative estimates for the PIP variable might be expected because of lower loss adjustment expenses for PIP coverage, the large magnitude of the estimates cannot be attributable only to this effect. For example, the estimate in equation 4 in Table 2 implies that a state with all PIP coverage and no liability coverage would have a ratio of premiums to losses lower by .69 than a state with zero PIP coverage. As noted, the large estimated effect is likely to reflect unanticipated growth in losses in states with no-fault. The positive estimates for THRESH would be consistent with this explanation (i.e., stricter thresholds experienced lower growth in losses). For detailed analysis of the effects of no-fault on loss costs, see Cummins and Weiss (1989).

The estimates for WAGE are close to zero, as are the t-values for this variable. The estimates for LIAB are positive but insignificant.

The results for the equations that exclude the deficit measure are consistent with those of recent studies that suggest a negative impact of voluntary market rate regulation on the ratio of premiums to losses. The estimate of α is positive ($-\hat{\alpha}$ is negative) and significant in each equation. The estimates of α are approximately equal for the liability and combined liability and physical damage equations. This result suggests that the overall impact of voluntary market rate regulation was similar for liability and physical damage coverage.

When the deficit measure is included, the estimates of δ are all less than one, and somewhat larger in the equations with the threshold variable and in the equations for combined liability and physical damage. While the latter result is consistent with a greater effect of deficits on voluntary market premiums for physical damage coverage, the difference in estimates would not be statistically significant. The absolute t-values for $\hat{\delta} - 1$ provide a test of the hypothesis that δ equals one. Since there is no reason to expect that δ would exceed one, it seems reasonable to state the alternative hypothesis as: $H_A: \delta < 1$, and to use a one-tailed test of significance. Even so, the t-values shown in Tables 2 and 3 would result in rejection of the null hypothesis at the .05 level of significance only for the regression for liability coverage that does not include the threshold variable (regression 2, Table 2).

With the exception of the liability coverage equation without the threshold variable, the estimates of the impact of voluntary market rate regulation ($-\hat{\alpha}$) remain significant at the .05 level or better for a one-tailed test when the deficit measure is added to the model.²³ These findings suggest that voluntary market rate regulation resulted in lower voluntary market premiums than would have occurred under competitive rating without any deficit unless the involuntary market deficit were large.²⁴

As noted, the formulation of equation (8) implies that voluntary market premiums exceeded the level that would occur under competition without any involuntary market deficit if $\delta > \alpha L_T/D$, which is equivalent to $D/L_T > \alpha/\delta$. Given this relation, the results for regression equation 3 (which constrains $\hat{\delta}$ to equal one) for liability and physical damage combined would imply that the deficit measure would need to exceed 7.3 percent in order for the predicted level of voluntary market premiums to exceed the level that would have occurred under competition without any deficit. Using the results of this regression and equation (7), the estimates imply an increase in voluntary market premiums (relative to the case with competitive rating and no deficit) equal to 70.8 percent of the deficit if $(D/L)_j = .25$ (i.e., $\hat{\theta} = 1 - .073 \times 4$).

²³ A one-tailed test is appropriate in view of the emphasis of insurance regulators on the affordability of coverage and the results of prior work. The correlation between REG and $REG \times (D/L)$ was about .42 for both liability and combined liability and physical damage.

²⁴ Statements concerning the level of voluntary market premiums in this section do not consider the possible effects of rate regulation on the number of uninsured drivers.

If, on the other hand, the results of regression 4 (with $\hat{\delta} < 1$) for liability and physical damage coverage combined were to be used, predicted voluntary market premiums would exceed the level that would exist under competition if the deficit measure exceeded 8 percent ($\hat{\alpha}/\hat{\delta} = .06/.75$), and the predicted increase in voluntary market premiums for $(D/L)_j = .25$ would equal 51 percent of the deficit ($\hat{\theta} = .75 - .06 \times 4$).

Given that the results generally do not support rejection of the hypothesis that $\delta = 1$ at conventional levels of significance, they are consistent with equation (6) with $\delta = 1$:

$$P_V = (\lambda - \alpha)L_V + D - \alpha L_I$$

which can be rewritten as

$$P_V = (\lambda - \alpha)L_V + [(\lambda - \alpha)L_I - P_I]$$

This equation suggests that rate regulation can be viewed as (1) having lowered the average premium loading for the overall market compared to the level that would have existed without rate regulation and (2) having allowed any difference between actual involuntary market premiums and the level implied by this loading to be recovered by increases in voluntary market premiums.

Conclusions

The results of this study are consistent with previous work that has found a negative impact of voluntary market rate regulation on the ratio of premiums to losses for the voluntary and involuntary markets combined. They also are largely consistent with the notion that the impact of rate regulation is uneven across consumers. They suggest larger reductions in the ratio of premiums to losses in the involuntary market and smaller reductions or even increases in the ratio of premiums to losses for the voluntary market.

It would be desirable for future research to conduct similar analysis for other periods and for other lines that often have large involuntary markets, such as workers' compensation insurance. Further research also is needed to explain the causes of large involuntary markets and deficits in auto insurance. Moreover, research is needed that analyzes the impact of lower ratios of premiums to losses in the overall auto insurance market on product quality and rates of entry and exit by insurers, and that investigates whether economies of scope or institutional factors could facilitate increases of premiums in other lines of business.

References

1. *AIPSO Insurance Facts* (New York, N.Y.: Automobile Insurance Plans Service Office, annual).
2. *Best's Executive Data Service* (Oldwick, N.J.: A.M. Best Co., annual).
3. Cummins, J. David and Mary Weiss, 1989, "An Economic Analysis of No-Fault," Working paper no. 89-4, Center for Research on Risk and Insurance, Wharton School, University of Pennsylvania.

4. Cummins, J. David and Jack Van Derhei, 1979, "A Note on the Relative Efficiency of Property-Liability Insurance Distribution Systems," *Bell Journal of Economics* 10: 709-19.
5. Grabowski, Henry, W. Kip Viscusi, and William Evans, 1989, "Price and Availability Tradeoffs of Automobile Insurance Regulation," *Journal of Risk and Insurance* 56: 275-299.
6. Harrington, Scott, 1984a, "The Impact of Rate Regulation on Automobile Insurance Loss Ratios: Some New Empirical Evidence," *Journal of Insurance Regulation* 3: 182-202.
7. _____, 1984b, "The Impact of Rate Regulation on Prices and Underwriting Results in the Property-Liability Insurance Industry: A Survey," *Journal of Risk and Insurance* 51: 577-623.
8. _____, 1987, "A Note on the Impact of Auto Insurance Rate Regulation," *Review of Economics and Statistics* 69: 166-70.
9. Ippolito, Richard, 1979, "The Effects of Price Regulation in the Automobile Insurance Industry," *Journal of Law and Economics* 22: 55-89.
10. Joskow, Paul, 1973, "Cartels, Competition and Regulation in the Property-Liability Insurance Industry," *Bell Journal of Economics and Management Science* 4: 375-427.
11. Keeler, Theodore, 1984, "Theories of Regulation and the Deregulation Movement," *Public Choice* 44: 103-45.
12. Keeton, William and Evan Kwerel, 1984, "Externalities in Automobile Insurance and the Uninsured Driver Problem," *Journal of Law and Economics* 27: 149-80.
13. Lee, Chong, 1989, "Economies of Scale and Scope for Direct Writers in the Property-Liability Insurance Market," Ph.D. dissertation, Wharton School, University of Pennsylvania.
14. Lee, J. Finley, 1977, *Servicing the Shared Automobile Insurance Market* (New York, New York: National Industry Committee).
15. Mintel, Judith, 1983, "The Effects of the Pricing of Private Passenger Automobile Insurance Sold through Residual Market Mechanisms on Competition and Market Structure," *Journal of Insurance Regulation* 1: 289-307.
16. Pauly, Mark, Paul Kleindorfer, and Howard Kunreuther, 1986, "Regulation and Quality Competition in the U.S. Insurance Industry," in *The Economics of Insurance Regulation*, edited by J. Finsinger and M. Pauly (London: MacMillan Press).
17. Rothschild, Michael and Joseph Stiglitz, 1976, "Equilibrium in Competitive Insurance Markets: An Essay on the Economics of Imperfect Information," *Quarterly Journal of Economics* 90: 629-49.
18. Smallwood, Dennis, 1975, "Competition, Regulation, and Product Quality in the Automobile Insurance Industry," in A. Phillips, ed., *Promoting Competition in Regulated Markets* (Washington, D.C.: The Brookings Institution).

19. U.S. General Accounting Office, 1986, *Auto Insurance: State Regulation Affects Cost and Availability* (Washington, DC: U.S. GAO).
20. Venezian, Emilio, 1984, "Cost-Based Pricing and Price-Based Costing in Private Passenger Auto Insurance," *Journal of Risk and Insurance* 51: 433-52.
21. Wenders, John, 1986, "Economic Efficiency and Income Distribution in the Electric Utility Industry," *Southern Economic Journal* 52: 1056-66.
22. Witt, Robert and Jorge Urrutia, 1983, "A Comparative Analysis of Tort Liability and No-Fault Compensation Systems in Automobile Insurance," *Journal of Risk and Insurance* 50: 631-69.

Table 1

Involuntary Market Deficit as a Proportion of Total Market Incurred Losses: 1979-81

State	Involuntary Market Deficit/ Total Market Incurred Losses			Involuntary Market Share	$\bar{P}_I/\bar{P}_T$
	Liability	Physical Damage	Combined		
1. Massachusetts	.392	.326	.364	.419	.958
2. New Jersey	.351	.226	.317	.348	1.033
3. North Carolina	.172	-	.109	.245	1.342
4. New Hampshire	.155	.184	.168	.221	1.298
5. South Carolina	.093	.224	.142	.207	1.514
6. Pennsylvania	.084	.013	.061	.049	1.746
7. Connecticut	.076	.083	.079	.122	1.427
8. New York	.074	.048	.066	.134	1.395
9. Rhode Island	.066	.166	.107	.084	1.439
10. Maryland	.050	.015	.039	.038	2.345
Other Regulated:					
Mean	-.002	.004	.001	.024	1.790
Maximum	.022	.036	.027	.113	3.077
Minimum	-.029	-.022	-.026	.001	1.160
All Competitive:					
Mean	.004	.003	.004	.015	1.896
Maximum	.043	.048	.044	.088	2.797
Minimum	-.005	-.004	-.004	.000	.506

Note: All values are means for the 1979-81 period. $\bar{P}_I$ and $\bar{P}_T$ denote estimated average liability premium per exposure for the involuntary and total market, respectively. The value of .506 for $\bar{P}_I/\bar{P}_T$ was for Hawaii, which provides free involuntary market coverage to welfare recipients.

Table 2
Results of Premium-to-Loss Regressions for Liability Coverage

Equation	Coefficients for Cost Variables					δ	$\delta-1$	$\bar{R}^2$
	Const.	LOSS	WAGE	PIP	THRESH			
1	1.765 (15.22)	-.199 (4.03)	-.003 (.19)	-.471 (3.32)	-.081 (2.61)			.51
2	1.783 (15.85)	-.145 (2.65)	-.007 (.48)	-.487 (3.54)	-.053 (1.59)	.498 (2.01)	-.502 (2.03)	.53
3	1.735 (15.50)	-.187 (3.92)	.006 (.42)	-.723 (4.09)	.118 (2.22)			.53
4	1.754 (15.86)	-.146 (2.74)	-.002 (.17)	-.692 (3.97)	.098 (1.84)	.601 (2.42)	-.399 (1.61)	.55

Note: The dependent variable is the ratio of premiums to losses for the total (voluntary and involuntary) market. LOSS = predicted loss per liability exposure (in \$100s) for the given coverage, WAGE = average wage rate for production workers, PIP = ratio of personal injury protection premiums to total liability premiums, and THRESH = 1 for no-fault states with either a verbal threshold or a monetary threshold of at least \$1000 and 0 for all other states. Average values of all variables for the period 1979 through 1981 were used. Absolute t-values are in parentheses.

Table 3
Results of Premium-to-Loss Regressions for Liability and Physical Damage Coverage Combined

Equation	Coefficients for Cost Variables						LIABx THRESH	- $\hat{\alpha}$	$\hat{\delta}-1$	$\hat{\delta}$	$\bar{R}^2$
	Const.	LOSS	WAGE	PIP	LIAB	LIABx THRESH					
1	1.755 (14.09)	-.153 (4.08)	.003 (.23)	-.303 (2.69)	.120 (.58)			-.075 (3.23)			.50
2	1.731 (14.06)	-.134 (3.47)	-.003 (.27)	-.317 (2.85)	.176 (.86)			-.058 (2.28)	-.322 (1.59)	.678 (3.40)	.52
3	1.728 (14.20)	-.152 (4.18)	.005 (.48)	-.462 (3.36)	.135 (.68)	.124 (1.91)		-.073 (3.21)			.53
4	1.714 (14.10)	-.137 (3.62)	.000 (.04)	-.450 (3.29)	.176 (.87)	.106 (1.61)		-.060 (2.39)	-.250 (1.23)	.750 (3.69)	.53

Note: See note to Table 2. LIAB is the ratio of incurred losses for liability coverage to incurred losses for liability and physical damage combined.

Copyright of Journal of Risk & Insurance is the property of Blackwell Publishing Limited and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.