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MEDICAL MALPRACTICE INSURANCE IN THE WAKE OF LIABILITY REFORM

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ABSTRACT

This article examines the effect of the liability reforms on medical malpractice insurance over the 1984–91 period. This is the first study to use data by firm and by state for every firm writing medical malpractice insurance over that time period. The liability reforms increased insurance profitability (that is, decreased the loss ratios), where the main mechanism of influence was through decreasing losses. The quantile regression estimates imply that the greatest effects of liability reform are on the most unprofitable firms and that the effect is not uniform across the entire market. This pattern is consistent with the other principal finding, which is that damages caps appear to be most influential.

I. INTRODUCTION

A PRINCIPAL target of the tort liability reform efforts in the 1980s was medical malpractice insurance. Unlike relatively stable insurance lines, such as homeowners' insurance and automobile insurance, medical malpractice premiums had escalated substantially in the mid-1980s, almost doubling in size from 1984 to 1986.¹ The rise in medical malpractice premiums has been blamed for a variety of ills of the health care sector.² Some observers suggested that medical malpractice premiums led doctors to change their fields of specialization to avoid high litigation pursuits. Others suggested that medical malpractice premiums led to unnecessary procedures and, particularly, unnecessary tests. More generally, some have blamed medical malpractice costs for the overall rise in health care

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¹ See Insurance Information Institute, *The Fact Book: 1992 Property/Casualty Insurance Facts 29* (1992).

² For a broader discussion of these issues, see Patricia M. Danzon, *Medical Malpractice* (1985); and Paul C. Weiler *et al.*, *A Measure of Malpractice: Medical Injury, Malpractice Litigation, and Patient Compensation* (1993).

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costs in the economy even though medical malpractice insurance premiums comprised under 1 percent of total health care costs.

To address these perceived ills of the medical malpractice liability system, a variety of states enacted reform measures in the mid-1980s. This effort echoed similar reform initiatives undertaken in the 1970s.³ The most popular types of reform were various types of damages caps, which pertained to noneconomic damages, punitive damages, and in some cases, the total value of all damages. To the extent that such constraints are binding, they will achieve the objective of cost reduction. However, the extent of the effect on cost reduction is unclear. In 1993, the chairman of the American Bar Association's working group on health care reform concluded that "[c]aps on noneconomic damages have not had the dramatic impact that supporters think."⁴

Damages caps may be binding in very few instances,⁵ and in those instances in which they are binding juries may find other ways to adjust the components of the award so that the effect on medical malpractice costs will not be substantial. The primary purpose of this article is to examine the effect of medical malpractice reforms, such as damages caps, on medical malpractice insurance costs in the 1980s.

In doing so, we will not question the underlying social desirability of the reform efforts but simply address their efficacy in achieving their intended objective of cost control. The structure of the medical malpractice reforms is certainly not ideal from the standpoint of tort liability reform.⁶ For example, a rigid damages cap of, for example, \$250,000 on

³ The 1970s reforms involved 43 states enacting legislation relating to tort law. Specifically, all states adopted legislation relating to insurance availability or medical discipline. The continuing rise in medical malpractice premiums prompted a second attempt to contain costs, with the primary focus on limiting damages awards. See Danzon, *supra* note 2, for a description of the earlier efforts.

⁴ See Associated Press release (August 9, 1993) for the statement of Clifford D. Stromberg, chairman of the American Bar Association Working Group on health care reform.

⁵ For documentation of the small frequency of cases that are affected by pain and suffering caps in the product liability area, see W. Kip Viscusi, Pain and Suffering in Product Liability Cases: Systematic Compensation or Capricious Awards? 8 *Int'l Rev. L. & Econ.* 203-20 (1988). A similar point is made with respect to medical malpractice caps by Danzon, *supra* note 2.

⁶ See, for example, the discussion in Paul C. Weiler, *Medical Malpractice on Trial* (1991); W. Kip Viscusi, *Reforming Products Liability* (1991); and American Law Institute, *Enterprise Responsibility for Personal Injury—Reporter's Study* (Vol. 1, *The Institutional Framework*, & 2, *Approaches to Legal and Institutional Change*) (1991). Detailed reviews of insurance market effects of tort liability are provided by Richard A. Epstein, *Modern Products Liability Law* (1980); George L. Priest, *The Invention of Enterprise Liability: A Critical History of the Intellectual Foundations of Modern Tort Law*, 14 *J. Legal Stud.* 461-527 (1985); George L. Priest, *The Current Insurance Crisis and Modern Tort Law*, 96 *Yale L. J.* 1521-90 (1987); Alan Schwartz, *Proposals for Products Liability Reform: A Theoretical*

noneconomic damages will continue to permit possibly excessive jury awards for insignificant injuries, such as temporary poisonings, while at the same time limiting awards to more deserving victims, such as the catastrophically injured, who may suffer from brain damage or paraplegia.⁷ More generally, a primary effect of such damages reforms is to limit the transfers from physicians and their insurers to plaintiffs in medical malpractice cases. It should be noted, however, that ultimately medical malpractice insurance costs will primarily be borne by patients.⁸

All limits of this type are clearly not desirable, since otherwise it would be optimal to abolish medical malpractice liability altogether. The social desirability of the reform efforts hinges not only on their efficacy in affecting liability costs but also on their effect on incentives to provide the efficient quality and quantity of health care and to provide appropriate levels of insurance to accident victims. A comprehensive assessment of the desirability of the reform efforts consequently would require a case-by-case analysis of the rationale and implications of the reform measures, which is beyond the scope of what is being undertaken here.

The principal issues we address pertain to the overall insurance market effects of the reform efforts in 1985–87.⁹ Most fundamentally, do medical malpractice liability reforms affect the profitability of insurance? Have these effects exerted themselves by decreasing the losses experienced by insurers, which one would expect if the reform efforts were successful, or do the reform efforts simply reflect an increased governmental interest in insurance profitability, which has led regulators to allow firms simply to raise premium levels? What has been the character of the effect of the reform efforts on the distribution of liability costs? Ideally, one would

Synthesis, 97 *Yale L. J.* 353–419 (1988); and Ralph A. Winter, Solvency Regulation and the Property-Liability “Insurance Cycle,” 29 *Econ. Inquiry* 458–71 (1991).

⁷ Some observers suggest that the appropriate cap on noneconomic damages would be to eliminate them altogether since individuals would not choose to provide compensation for pain and suffering losses. Others have suggested that in situations where deterrence is a principal concern, compensation for pain and suffering should be much larger than current liability awards.

⁸ See Patricia M. Danzon, Mark V. Pauly, & Raynard S. Kington, The Effects of Malpractice Litigation on Physicians’ Fees and Incomes, 80 *Am. Econ. Rev.* 122–27 (1990).

⁹ A number of studies evaluate alternative measures of the effectiveness of the liability reforms. These include a study of physician malpractice premiums, claims, and awards (Stephen Zuckerman, Randall R. Bovbjerg, & Frank Sloan, Effects of Tort Reforms and Other Factors on Medical Malpractice Insurance Premiums, 27 *Inquiry* 167–82 (1990)), and several studies of the effects of the reforms on the frequency and disposition of medical malpractice claims. See, for example, James W. Hughes & Edward A. Snyder, Evaluating Medical Malpractice Reforms, 7 *Contemp. Pol’y Issues* 83–98 (1989); and Danzon, *supra* note 2.

expect reform efforts to be most effective in shifting the upper tail of the distribution of losses and, hence, firms' profitability. In a competitive market, these profitability effects may be short-run.¹⁰ Thus, the effects of the liability reforms should not be uniform throughout the entire market, but instead should have a differential effect throughout the distribution of the insurance market. The difference in these effects will be a principal concern.

Section II will begin the analysis with an examination of the liability reform experiments in Michigan and Wisconsin. These efforts were more narrowly focused than most, as they consisted of a reform effort in a single year, consisting primarily of a damages cap. As a result, they provide a useful starting point for examining the implications of liability reform.

The remainder of the article will focus on liability reform on a national basis, where the types of measures considered and their timing will be much more diverse. Section III introduces the sample to be used for the examination of the national effects of medical malpractice liability reforms. The data set that will be used for this analysis as well as for the state-level analysis is on a firm-specific basis, where data are available by year for each state in which the firm operates. This very rich data set, which includes over 10,000 observations, provides a much more refined statistical basis for analysis than the aggregative data by state that are the focus of most analyses of insurance. Section IV examines the effects of liability reforms on the most widely used profitability measure—loss ratios, that is, the ratio of losses to premiums. In addition to presenting the usual regression models, this section also introduces the use of quantile regression models to examine the effect of liability reform on the distribution of loss ratios. The examination of the effect of liability reform on loss and premium levels in Section V suggests that liability reform exerted its impact by reducing loss levels, and there is some limited evidence that these reduced losses were passed through as lower premiums. Overall, a substantial part of the reversal in the fortunes of the medical malpractice insurance market since the mid-1980s can be credited to the liability reform efforts.

II. LIABILITY REFORM EXPERIMENTS: MICHIGAN AND WISCONSIN

It is instructive to begin examining the effect of liability reform measures with two narrowly defined liability reform experiments undertaken

¹⁰ For example, there will be price competition that can arise even in a regulated environment if physicians can form their own mutuals or reciprocals.

in Michigan and Wisconsin. These state efforts were both 1986 statutes targeted primarily at limiting damages.

In the case of Michigan, the medical malpractice reform consisted of a cap of \$225,000 in noneconomic damages on medical malpractice actions.¹¹ This cap is to be adjusted to reflect changes in the consumer price index. The cap does not apply in wrongful death actions, actions involving reproductive system injuries, or actions for loss of a vital bodily function. The medical malpractice reform measure did include some other minor provisions pertaining to stricter standards for expert witnesses, a new mediation system, and a change in the statute of limitations. In addition to the medical malpractice reform effort, Michigan also enacted a more general tort liability reform measure for which some of the provisions may have had pertinence to medical malpractice insurance as well. The tort liability reform provisions included limitations on joint and several liability, sanctions on frivolous suits, admission of collateral benefits, periodic payment of judgments for future damages over \$250,000, limitations on dramshop liability, and mediation for civil actions other than medical malpractice.¹²

The reform efforts in Wisconsin were more limited in that a single provision constituted the focal point of the reform.¹³ In particular, medical malpractice damages were capped at \$1 million. Even the lost earnings and medical expense component of damages could not exceed \$1 million. Whereas many tort liability reform proponents have provided potentially sound rationales for limits on noneconomic damages, there has been far less support for a more general cap on the total value of liability awards, particularly given the substantial medical expenses that may be required to rehabilitate accident victims. The other provisions of the Wisconsin reform effort were relatively minor, as they pertain to regulation of attorney fees in malpractice actions and more stringent medical disciplinary standards.

The sample used in this and subsequent analyses is the data set developed by the National Association of Insurance Commissioners (NAIC) for state insurance regulation. Every property and liability company in each state is required to submit financial data to the NAIC on a yearly basis. Thus, this data set includes information on every firm selling medical malpractice insurance nationally. For Michigan and Wisconsin, the sample size includes 61 firms writing medical malpractice insurance in Michigan and 48 firms writing medical malpractice insurance in Wisconsin.

¹¹ Mich. H.B. 5154 83d Leg. (1986).

¹² See *id.*

¹³ Wis. A.B. 4 1985–87 biennial sess. (1986) (special session).

sin. Data are available on a yearly basis for 1984–91. The information available for each firm is quite comprehensive, as it includes data by state and by line on premiums and losses.

A principal reference point for the analysis will be to examine how the performance of medical malpractice insurance in these states has compared with that of automobile insurance. The number of firms writing automobile insurance is considerably larger, as it is 264 in Michigan and 332 in Wisconsin. Automobile insurance was not affected by liability reform efforts within these states over this period and serves as a useful benchmark for examining the overall effect of economic conditions on the likely performance of liability insurance generally. We will then compare the performance of medical malpractice insurance with that of automobile insurance to examine the difference in the performance in these two lines and, in particular, how this difference in performance shifted in the wake of medical malpractice liability reform.

In choosing auto insurance as the reference point, this analysis will capture insurance market trends generally but will abstract from many of the distinctive characteristics that affect medical malpractice. The medical malpractice line is more similar to general liability insurance than automobile insurance in two respects. First, medical malpractice and general liability have each been affected by the expansion in tort liability, whereas automobile insurance has been more stable. Second, as in the case of medical malpractice, general liability has also been the target of a wide range of reform efforts. Because of the potential influence of these reforms, which have been as numerous for general liability as for medical malpractice, general liability does not serve as a good reference point for how insurance markets might have performed in the absence of reform measures. It should be recognized, however, that automobile insurance does not fully capture all of the key aspects of the medical malpractice line, and, as a result, the regression analysis below will undertake a much more comprehensive analysis in order to address such issues.¹⁴

The loss ratio is the principal measure of insurance profitability. The loss ratio can be viewed as the inverse of the ex post price of insurance, or the dollar amount of insurance coverage provided for each dollar in premiums. More specifically, the loss ratio is the ratio of the losses attributable to premiums written in a particular year to the value of the premiums earned in that year, where the loss values have been adjusted using

¹⁴ One key difference between these lines is the length of the payout tail, or the lag between the receipt of premiums and the resulting payment of claims. This duration is longer for medical malpractice, making this line more sensitive to interest rate changes.

development factors based on industry aggregate loss experience to account for prospective losses that have not yet been accounted for in the data. This pattern of rising and then falling loss ratios is not atypical of the insurance industry. This phenomenon occurs with sufficient frequency and has been designated the underwriting cycle or the liability insurance cycle.¹⁵ The decline in loss ratios beginning in 1986 consequently may reflect either liability reforms or other time-related influences not captured in these simple differences, such as those related to the liability insurance cycle. The regression analysis below will include appropriate measures of general economic conditions to capture such influences. Moreover, it also should be noted that much greater stability is exhibited by automobile insurance, for which the loss ratios range from 0.7 to 1.0 throughout this time interval for both states.¹⁶ The performance of loss ratios represents a principal focal point of analysis in the insurance literature dealing with the performance of liability insurance.

The structure of the analysis of the medical malpractice liability reform experiments in Wisconsin and Michigan can be characterized as the following. The state loss ratio for line l in state s in year t consists of four components: a time-specific line effect, b_{lt} ; a time-varying trend effect for the state, c_{st} ; a line-varying effect for the state, d_{ls} ; and an error term that depends on the line, the state, and the year, e_{lst} . This gives rise to the formulation

$$\text{Loss Ratio}_{lst} = b_{lt} + c_{st} + d_{ls} + e_{lst}. \quad (1)$$

The first expression that will be derived will be to analyze the changes in the loss ratio for the medical malpractice line over time. In particular, how does the loss ratio in year t compare with the loss ratio in year $t - j$, where the time periods should be selected to capture the before and after reform era? Upon taking the appropriate differences for equation (1) for years t and $t - j$, one obtains

$$\begin{aligned} \text{Loss Ratio}_{lst} - \text{Loss Ratio}_{lst-j} &= (b_{lt} - b_{lt-j}) + (c_{st} - c_{st-j}) \\ &+ (e_{lst} - e_{lst-j}). \end{aligned} \quad (2)$$

The change in loss ratios over time consists of three components, the last of which is an error term. The first component is the line-specific

¹⁵ See Joseph A. Fields & Emilio C. Venezian, Interest Rates and Profit Cycles: A Disaggregated Approach, 56 *J. Risk & Ins.* 312-19 (1989); Winter, *supra* note 6; and Anne Gron, Capacity Constraints and Cycles in Property-Casualty Insurance Markets, 25 *RAND J. Econ.* 110-27 (1994).

¹⁶ The comparison group, "automobile insurance," is composed of all insurers in automobile liability and physical damage lines.

change over time. This term will reflect the effect of the medical malpractice liability reform as well as any other shifts that affect the performance of medical malpractice insurance over time. The second component of equation (2) is the change over time of the state-specific loss ratio component. Factors that affect the change in the loss ratio over time in the state, such as the change in the state wage rate, will consequently be reflected in this term.

If instead one calculates the difference in the loss ratios across insurance lines at any point in time, such as between medical malpractice insurance and automobile, as opposed to within-line differences over time, the expression is given by

$$\text{Loss Ratio}_{mst} - \text{Loss Ratio}_{ast} = (b_{mt} - b_{at}) + (d_{ms} - d_{as}) + (e_{mst} - e_{ast}). \quad (3)$$

The first component of the loss ratio difference represents the difference in the line-specific time-varying effect. In the postreform era, this term will reflect the influence of liability reform on b_{mt} . The second component of equation (3) represents the difference in the state-specific performance of each particular line, and the final term is the error term.

The final comparison is to analyze the difference in the differences of the loss ratios between lines, or

$$\begin{aligned} & (\text{Loss Ratio}_{mst} - \text{Loss Ratio}_{mst-j}) \\ & - (\text{Loss Ratio}_{ast} - \text{Loss Ratio}_{ast-j}) \\ & = (b_{mt} - b_{mt-j}) - (b_{at} - b_{at-j}) + \gamma_t, \end{aligned} \quad (4)$$

where

$$\gamma_t = e_{mst} - e_{ast} - e_{mst-1} + e_{ast-1}.$$

The difference in the differences includes two components other than the error term, but each of these components represents changes in the line-specific performance over time. The first component on the right side of equation (4) is the change in the time-specific effect of medical malpractice insurance, which should reflect the influence of liability reform that occurred between years $t - j$ and year t . The second term represents the shift in the automobile insurance time-varying component over the same period. To the extent that this term isolates the change in insurance market performance over time more generally, it will serve to net out of the first term—the change in the medical malpractice time-varying term—all influences other than the effect of tort liability.

An examination of the performance of medical malpractice insurance indicates the striking effect of the 1986 reform efforts in Michigan and

TABLE 1
MICHIGAN LOSS RATIOS, 1984-91: MEDICAL MALPRACTICE VS. AUTOMOBILE

A. LOSS RATIOS								
	1984	1985	1986	1987	1988	1989	1990	1991
Medical malpractice (MM):								
Mean	1.428	1.615	.874	.988	.780	.630	.659	.723
Standard error	.182	.592	.362	2.669	.130	.057	.066	.052
Automobile:								
Mean	.858	.855	.882	1.027	.811	.942	.975	.755
Standard error	.028	.024	.025	.050	.020	.023	.032	.028
MM - Auto	.570*	.760	-.008	-.040	-.031	-.312*	-.316*	-.033
Standard error	.184	.592	.363	2.669	.131	.062	.073	.059
B. LOSS RATIO DIFFERENCES								
	1986 - 1985	1987 - 1985	1988 - 1985	1989 - 1985	1990 - 1985	1991 - 1985		
MM mean	-.741	-.628	-.835	-.985*	-.957	-.893		
Standard error	.694	2.734	.606	.594	.595	.594		
Auto mean	.027	.173*	-.044	.087*	.120*	-.100*		
Standard error	.035	.056	.031	.033	.040	.037		
MM - Auto	-.768	-.800	-.791	-1.072*	-1.076*	-.793		
Standard error	.579	2.735	.607	.595	.596	.595		

* Significant at the .05 level, one-tailed test, using the two-sample z-test.

Wisconsin. Table 1 provides loss ratio information for Michigan, and Table 2 includes comparable information for Wisconsin. All loss ratios in these tables have been weighted by premiums earned and pertain to the ratio of losses incurred to premiums earned for each year.¹⁷ The top panels of the tables present information by year with respect to the loss ratios for both medical malpractice and automobile insurance as well as the difference in these ratios, and the bottom panels present information on the differences with respect to the prereform year 1985.

In both Michigan and Wisconsin, the loss ratios were at a level that generated underwriting losses over the 1984-85 period, as the medical malpractice loss ratios ranged from 1.4 to 1.7.¹⁸ Beginning in 1986, there was a dramatic downward shift in loss ratios for both Michigan and Wisconsin, and from 1987 and thereafter these loss ratios were consistently below 1.0.

¹⁷ This weighting scheme results in a value for the loss ratio which is essentially the state-level loss ratio: state total losses divided by total premiums.

¹⁸ Underwriting losses do not necessarily imply real economic losses since losses are not discounted, or, viewed somewhat differently, there is a rate of interest that can be earned on premiums that must be recognized.

TABLE 2
 WISCONSIN LOSS RATIOS, 1984-91: MEDICAL MALPRACTICE VS. AUTOMOBILE

A. LOSS RATIOS								
	1984	1985	1986	1987	1988	1989	1990	1991
Medical malpractice (MM):								
Mean	1.691	1.658	1.113	.652	.605	.497	.735	.542
Standard error	.423	.954	.050	.100	.029	.038	.082	.047
Automobile:								
Mean	.831	.836	.711	.666	.710	.749	.742	.710
Standard error	.017	.018	.019	.014	.013	.012	.014	.019
MM - Auto	.860*	.822	.401*	-.014	-.105*	-.252*	-.007	-.168*
Standard error	.423	.954	.054	.101	.032	.040	.083	.051
B. LOSS RATIO DIFFERENCES								
	1986 - 1985	1987 - 1985	1988 - 1985	1989 - 1985	1990 - 1985	1991 - 1985		
MM mean	-.545	-1.006	-1.053	-1.160	-.923	-1.116		
Standard error	.955	.959	.954	.954	.957	.955		
Auto mean	-.125*	-.170*	-.126*	-.086*	-.094*	-.126*		
Standard error	.026	.023	.022	.022	.023	.026		
MM - Auto	-.421	-.836	-.927	-1.074	-.829	-.990		
Standard error	.955	.959	.954	.954	.957	.955		

* Significant at the .05 level, one-tailed test, using the two-sample z-test.

The first set of differences presented in (the MM - Auto rows of) Tables 1 and 2 pertain to the differences between medical malpractice and automobile insurance. These differences are positive for the pre-reform period before 1986, and there is a stark drop that begins in 1986 in Michigan and which takes place over the 2-year period 1986-87 in Wisconsin. The positive difference is statistically significant in 1984, and the negative differences are statistically significant in 1989 and 1990.

The bottom panels of Tables 1 and 2 present information with respect to the differences relative to the pre-reform year of 1985. Whereas these differences are comparatively small and often statistically insignificant for automobile insurance, in the case of medical malpractice these differences are consistently substantial. Moreover, the extent of the difference does not dissipate over time, so that liability reform did not simply have a temporary effect on profitability. Rather, there was a long-term shift of the loss ratios over time.

The difference in the change in medical malpractice loss ratios and the auto insurance loss ratios over time (that is, the difference in the differences) appears in the bottom row of Tables 1 and 2. These effects also imply a shift from the loss ratio levels before 1986, as the magnitude of the difference in the differences ranges from 0.4 to 1.08. In two of the cases, the differences are statistically significant.

TABLE 3
LOSS RATIOS: MEDIANS AND 75th PERCENTILES
(Standard Errors Are in Parentheses)

A. MICHIGAN								
	1984	1985	1986	1987	1988	1989	1990	1991
Medical malpractice:								
Median	1.094 (.034)	1.421 (.034)	.848 (.026)	1.096 (.036)	.591 (.013)	.532 (.013)	.677 (.010)	.486 (.010)
75th percentile	4.025 (.132)	3.213 (.152)	1.706 (.091)	2.622 (.101)	.802 (.014)	.728 (.028)	.975 (.015)	.863 (.016)
Automobile:								
Median	.741 (.003)	.762 (.003)	.642 (.002)	.693 (.003)	.660 (.002)	.709 (.003)	.668 (.002)	.623 (.002)
75th percentile	1.319 (.005)	1.237 (.005)	.937 (.005)	1.143 (.006)	1.109 (.005)	1.272 (.010)	1.188 (.008)	1.179 (.007)
B. WISCONSIN								
	1984	1985	1986	1987	1988	1989	1990	1991
Medical malpractice:								
Median	.876 (.027)	.923 (.040)	.507 (.031)	.576 (.019)	.612 (.010)	.518 (.016)	.669 (.035)	.545 (.011)
75th percentile	1.654 (.049)	3.219 (.196)	1.205 (.046)	1.251 (.050)	.856 (.027)	.732 (.022)	2.295 (.173)	.763 (.014)
Automobile:								
Median	.760 (.002)	.762 (.001)	.687 (.001)	.628 (.002)	.644 (.001)	.648 (.002)	.668 (.002)	.668 (.001)
75th percentile	1.184 (.004)	1.096 (.003)	.952 (.002)	.893 (.002)	.903 (.002)	.899 (.002)	.968 (.002)	.909 (.002)

To examine the effect of liability reform on the loss ratio distribution, Table 3 presents the pertinent loss ratio statistics for the median and seventy-fifth percentile of the loss ratio distribution. To the extent that the liability reforms are most effective in reducing the substantial losses and the very high loss ratios, the effect should not be uniform but instead should be concentrated at the upper end of the distribution. The damages caps component of the liability reforms particularly should tilt the effects of the reform efforts toward the higher loss situations.

The results in Table 3, panel A, for Michigan and Table 3, panel B, for Wisconsin are consistent with this differential effect. From 1985 to 1991 the median loss ratio in Michigan for medical malpractice drops by 0.9, whereas the seventy-fifth percentile of the loss ratio distribution declines by 2.3. In contrast, the performance of the automobile line loss ratio medians and seventy-fifth percentile is relatively invariant, but these effects are not particularly comparable since medical malpractice loss ratios tend to be more skewed. A similar and somewhat starker trend is exhib-

ited in the state of Wisconsin in Table 3, panel B. The loss ratio median for medical malpractice declined by 0.4 from 1985 to 1991, whereas the decline for the seventy-fifth percentile was 2.4. The effects of the liability reforms are most pronounced at the upper end of the distribution.

III. SAMPLE CHARACTERISTICS FOR THE NATIONAL DATA ANALYSIS

The examination of the effect of the medical malpractice liability reforms nationwide will also be undertaken using data from the National Association of Insurance Commissioners. These data are available for 1984–91, but since the lagged dependent variable will be included in the analysis, the focus will be on the years 1985–91. Each observation in the sample pertains to the total policies written by a firm that year in a particular line of insurance in a particular state. The total number of firm-state combinations for the medical malpractice line was 1,475 in 1985 and 1,302 in 1991 (see Table 4).¹⁹ A panel data set was created, which includes all firms writing coverage in medical malpractice and includes the information on premiums earned, losses incurred (detailed in the top panel of Table 4), as well as information pertaining to the firm such as its organizational form—Lloyds, mutual, or reciprocal—and total assets of the firm nationally. Lloyds associations consist of individual underwriters, each of whom are responsible only for a portion of the risk that they have underwritten. Mutual insurers and reciprocals each function as cooperatives in which the policyholder acts as an owner as well.²⁰ The omitted organizational form is that of stock companies, which account for 92 percent of all firms in the sample. As indicated in panel A of Table 4, beginning in 1986 average premiums earned per firm in each state rose from under \$2 million to over \$3 million, and losses incurred also rose, but not by as great an amount. The loss ratio, which was calculated on a firm-specific basis using the information above, declined from 1.1 in 1985 to 0.73 in 1991.

Using information with respect to the state in which the insurance

¹⁹ Over 8,000 observations are used in the empirical analysis, compared to 350 for a comparable analysis using state aggregative data. The previous research on medical malpractice insurance uses state aggregative data to analyze the effects of the liability reforms. These studies include an analysis of the reforms of the early 1970s (Drucilla K. Barker, *The Effects of Tort Reform on Medical Malpractice Insurance Markets: An Empirical Analysis*, 17 *J. Health Pol. Pol'y & L.* 143–61 (1992)) and a more recent study of the mid-1980s reforms and their effects on both the general liability and medical malpractice lines (W. Kip Viscusi *et al.*, *The Effect of 1980s Tort Reform Legislation on General Liability and Medical Malpractice Insurance*, 6 *J. Risk & Uncertainty* 165–86 (1993)).

²⁰ Reciprocals differ from mutuals in that reciprocals are unincorporated and managed by an attorney-in-fact, whereas mutuals are incorporated entities run by an elected board of directors.

TABLE 4
SAMPLE CHARACTERISTICS

A. PREMIUMS, LOSSES, AND LOSS RATIOS, 1985-91: MEANS (Standard Deviations)							
	1985	1986	1987	1988	1989	1990	1991
Premiums earned (in Millions)	1.843 (9.166)	3.159 (13.228)	3.998 (15.018)	4.202 (16.169)	3.638 (14.847)	3.441 (14.313)	3.087 (13.581)
Losses incurred (in Millions)	2.195 (11.757)	3.107 (17.531)	3.387 (18.633)	3.232 (18.754)	2.161 (7.894)	2.198 (8.825)	2.264 (10.290)
Loss ratio	1.191 (7.583)	.990 (25.694)	.847 (11.005)	.770 (3.461)	.595 (9.423)	.640 (4.193)	.734 (12.217)
B. OTHER VARIABLES: MEANS (Standard Deviations)							
					1985	1991	
Reform variables:							
Any reform					.375 (.484)	.895 (.307)	
Collateral Source					.0 (.0)	.359 (.480)	
Attorney Fees					.0 (.0)	.131 (.337)	
Damages					.062 (.241)	.550 (.498)	
Other reforms					.336 (.473)	.845 (.362)	
Past reform efforts:							
Ceilings on Recoveries (1975-76)					.227 (.419)	.229 (.420)	
Attorney Fees (1975-76)					.509 (.500)	.489 (.500)	
Collateral Source (1975-76)					.405 (.491)	.386 (.487)	
Regulation variables:							
Prior Approval or Modified Prior Approval					.284 (.451)	.302 (.459)	
Flex Rating					.114 (.318)	.114 (.318)	
Use and File/File and Use					.542 (.498)	.522 (.500)	
Miscellaneous:							
Organizational form:							
Lloyds					.003 (.058)	.001 (.028)	
Mutual					.068 (.252)	.085 (.279)	
Reciprocal					.020 (.139)	.038 (.192)	
Total assets (in millions)					1,376.896 (56.644)	1,248.953 (82.162)	
National premiums written (in millions)					31.532 (1.960)	36.688 (1.813)	
State aggregate income (in billions)					88.293 (2.497)	108.057 (3.187)	
Treasury-Bill Rate					7.470	5.380	
N					1,475	1,302	

policy was written, we constructed information pertaining to the insurance regulation regime and the presence of different kinds of liability reforms. Three types of insurance regulation were distinguished. The most common form of regulation is use and file/file and use, in which filings on insurance rates are required either before or after the use of these rates. The state insurance department has the right to review and possibly reject the use of these rates. The second most frequent type of state insurance regulation for medical malpractice is prior approval or modified prior approval regulation, under which rates must be filed and approved by the state insurance department before a firm may use them. The flex rating states impose a prior approval requirement only if the extent of the rate increase exceeds a specified rate increase percentage above the previously filed rates. The omitted regulation category is that of no insurance rate regulation.

The primary matter of empirical interest will be the liability reform variables pertaining to the mid-1980s tort liability reforms. The first variable pertaining to whether a state enacted any reform pertaining to medical malpractice insurance represents an effort to capture the overall effect of medical malpractice and liability reforms without distinguishing the particular nature of the reform effort. The fraction of the firms in states that have undertaken such liability reforms rose from 37.5 percent in 1985 to 89.5 percent in 1991. The four types of 1980s reform efforts that will be broken out separately are reforms pertaining to collateral sources, attorney's fees, damages limits, and other reforms.

A more detailed summary of the states enacting reforms and the types of reform efforts enacted in these states from 1984 to 1987 appears in Table 5.²¹ Most of the reform efforts were concentrated in 1986. The first column of reform efforts pertains to medical malpractice, and the second column pertains to general liability reforms, which may affect medical malpractice liability as well. A state may appear in this tabulation more than once. For example, Illinois undertook medical malpractice reforms in 1985, general liability reforms in 1985, and additional general liability reforms in 1986. Most of these reform efforts involve some type of damages cap, where these include caps on punitive damages, caps on noneconomic damages, limitations on the circumstances in which damages may be awarded, barring of punitive damages altogether, and monetary caps on total medical malpractice damages. The collateral source rule reforms typically pertain to offset provisions whereby private medical insurance coverage will be taken into account when studying damages amounts.

²¹ Liability reform descriptions were obtained from the Alliance of American Insurers, Civil Justice Enactments Bulletin (1985-87).

TABLE 5
SUMMARY OF STATES ENACTING DAMAGES LIMITATIONS

YEAR	MEDICAL MALPRACTICE		GENERAL LIABILITY	
	State	Code(s)*	State	Code(s)*
1985	Florida	3	Illinois	1
	Illinois	4	Montana	3
	Kansas	1, 3	Rhode Island	1
	South Dakota	1		
1986	Kansas	2, 5	Alaska	2
	Massachusetts	2	Colorado	1
	Michigan	2	Florida	2, 3
	Missouri	2	Illinois	3
	South Dakota	2	Maryland	2
	Utah	2	Minnesota	2
	West Virginia	2	New Hampshire	2
	Wisconsin	5	Oklahoma	1
			Washington	2
1987	Alabama	5	Alabama	1
			California	3
			Georgia	3
			Hawaii	1
			Idaho	3
			Indiana	3
			Iowa	3
			Kansas	3
			Missouri	3
			Montana	3
			North Dakota	3
			Ohio	3
			Oregon	2, 3
			South Carolina	2, 3
			Texas	1
		Virginia	1	

NOTE.—Code descriptions: 1 = monetary cap on punitive damages; 2 = monetary cap on noneconomic damages; 3 = limitations on circumstances in which damages may be awarded; 4 = punitive damages barred in medical malpractice actions; 5 = monetary cap on all medical malpractice damages.

Limitations on attorney's fees and specific other reforms tended to be less frequent than the collateral source rule and damages provisions.

Ideally, it would be useful to establish a uniform quantitative metric by which the stringency of the reform efforts could be calibrated. Reform efforts could be scored on this dimension and one could determine, for example, how a change in a nonmonetary damages cap from \$100,000 to \$200,000 would affect medical malpractice liability. Unfortunately, the substantial heterogeneity of the reform efforts, the large qualitative component of the reform measures, and the diversity of the reform actions

included with any single reform package make it infeasible to undertake the kind of precise quantitative assessments that one would like. Nevertheless, it will be possible to distinguish the average influence of the reform efforts and, in some cases, to assess the role of the particular reform components.

Although the primary focus of the article is on the liability reforms undertaken in the 1980s, there was a similar liability reform effort that took place in the 1970s. Over the 1975–76 period a large number of states enacted liability reforms in an effort to stabilize medical malpractice insurance. These variables, which are summarized in panel B of Table 4, are dummy variables pertaining to whether the state in which the insurance company is writing coverage has adopted a particular reform. The three different reform types that will be distinguished are ceilings on recoveries, provisions pertaining to attorney's fees, and collateral source rules. These measures were not as widespread as some of the 1980s reforms, but a substantial part of the sample is affected, ranging from one-fourth to half of the firms. These tort liability reforms enacted before 1984 may have a long-run influence on firm profitability.²²

The final variables appearing at the bottom of panel B of Table 4 pertain to other variables that will be included in the insurance analysis. The next two measures relate to the particular firm based on the NAIC data—total assets and national premiums written. The State Aggregate Income variable was constructed using information on the state in which the insurance firm wrote the policy, and the U.S. Treasury-Bill Rate is the real inflation-adjusted 3-month Treasury-bill rate.²³

IV. NATIONAL LOSS RATIO EFFECTS

One objective of the liability reform effort was to stabilize the performance of liability insurance markets. The most widely used measure of insurance market performance is the loss ratio, which gives the loss amounts per dollar of premiums earned. Because this measure adjusts for the amount of insurance written, it constitutes a more meaningful measure of the effect on insurance profitability than does examining the total value of losses. For example, the magnitude of insurance losses might have substantially decreased, but this might not necessarily indi-

²² Measures imposing limits on awards were especially vulnerable to constitutional challenges. In 17 states where they were enacted, 5 state supreme courts declared the limits invalid. Only measures that survived the period have been used in this analysis.

²³ Aggregate income data were obtained from the U.S. Department of Commerce, Survey of Current Business (various years). The U.S. Treasury-bill rate is published in the U.S. Department of Commerce, Statistical Abstract of the United States (1992).

cate a change in the liability burden, as one would obtain the same effect if firms simply ceased to write medical liability insurance.

The basic specification of the equation is an autoregressive model that also includes a dummy variable or a set of dummy variables for tort liability reforms as well as a series of explanatory variables, where the equation takes the form

$$\text{Log Loss Ratio}_{it} = \alpha_1 + \beta_1 \text{Log Loss Ratio}_{it-1} + \gamma_1 \text{Reform}_{it} \quad (5) \\ + \sum_{j=1}^N \delta_j X_{jit} + \epsilon_{lit},$$

where all X_{jit} are in logs. The lagged value of the loss ratio is expected to have a positive effect on the current value, where this coefficient will be 1.0 if the profitability of insurance policies written by a firm is constant from year to year, as would be the case if the mix of insured and their loss experience remained invariant over time. Due to the stochastic nature of losses, this is unlikely to be the case.

The reform measure will be in terms of a 0-1 dummy variable for whether the state enacted some type of tort liability reform for either medical malpractice or general liability. In addition, each equation will be reestimated, replacing the single aggregative reform variable with a series of four detailed reform variables pertaining to limits on damages, collateral source rules, attorney fees, and other reform efforts. Because of the high correlation among the different reform efforts within tort liability reform packages, it is difficult to distinguish the influence of all these various reform components. For example, it is not possible to reliably estimate the differential effects of medical malpractice reforms as opposed to general liability reforms, many of which were contemporaneous.

The other explanatory variables include a series of variables pertaining to reform efforts prior to 1984, the state insurance regulatory regime (Prior Approval or Modified Prior Approval, Flex Rating, and Use and File/File and Use),²⁴ three variables pertaining to the organizational form (Mutual, Reciprocal, and Lloyds), the level of national premiums written to control for the size and mix of the insurance market, the level of state aggregate income which affects the wage rate in the state, and the cost of providing insurance as well as the magnitude of losses. The final variable is the real Treasury-Bill Rate, as higher real rates of return enable firms to offer insurance policies with a higher loss ratio and still maintain insurance profitability.

In addition to estimating each of the equations using ordinary least

²⁴ State rate regulation variables were obtained from the NAIC.

squares, we also present two other sets of estimates. The first of these are weighted least squares estimates, where the weights pertain to the total value of the assets of the particular firm. This adjustment is intended to address the influence of heterogeneity of firms of different sizes. In the absence of such weight, firms with very little insurance business would be given the same weight as firms that had a large market share. Weights based on asset levels were used rather than premiums since subsequent regressions will use premiums as the dependent variable, and the loss ratio is a function of premiums. A final set of estimates using a fixed effects model including state-specific effects is also presented, where these capture all time-invariant state characteristics affecting either liability regimes or other economic conditions influencing the performance of insurance policies.

The estimates presented in Table 6 follow many of the expected patterns. This equation is similar in character to many that have appeared in the literature.²⁵ For example, the lagged loss ratio has a consistent positive effect on the current loss ratio. The three 1975–76 reform variables are not statistically significant, possibly because whatever influence they have had is reflected in the lagged value of the dependent variable.

The main matter of concern is the effect of the 1980s liability reform measures. The estimates in the top panel of Table 6 pertain to the aggregative liability reform measure and consequently will capture the average effect of all tort liability reform efforts. These estimates suggest that the short-run effect of tort liability reform is to decrease the loss ratio by an average of 19 percent for the ordinary least squares and weighted least squares estimates and by 39 percent for the fixed effects estimates. Thus, taking into account the additional role of time-invariant, state-specific effects leads to a higher estimated impact of a liability reform on medical malpractice insurance profitability. The long-run effects, which take into account the effect through the lagged loss ratio as well are roughly double in size—39 percent, 41 percent, and 78 percent for each of the three equations.²⁶

Similar results are obtained when one reestimates these equations re-

²⁵ See, for example, J. David Cummins & Scott E. Harrington, *The Impact of Rate Regulation in U.S. Property-Liability Insurance Markets: A Cross-Sectional Analysis of Individual Firm Loss Ratios*, Geneva Papers Risk & Ins., 1987, No. 42, at 50–62.

²⁶ For example, to calculate the long-run effects of reform for the ordinary least squares estimates, one has an equation of the form

$$\text{Log Loss Ratio}_t = 1.849 + 0.512 \text{ Log Loss Ratio}_{t-1} - 0.188 \text{ Reform}_t$$

Since $\text{Log Loss Ratio}_t = \text{Log Loss Ratio}_{t-1}$ in long-run equilibrium, the effect of the Reform variable on the Log Loss Ratio is consequently $-0.188/(1 - 0.512)$.

TABLE 6
LOG LOSS RATIO REGRESSION RESULTS

	Ordinary Least Squares	Weighted Least Squares	Fixed Effects
Intercept	1.849* (.310)	1.888* (.314)	a
Log Loss Ratio _{t-1}	.512* (.011)	.522* (.011)	.503* (.011)
Reform	-.188* (.040)	-.197* (.040)	-.387* (.054)
Ceiling on Recoveries (1975-76)	-.042 (.044)	-.039 (.045)	a
Attorney Fees (1975-76)	-.002 (.038)	.001 (.038)	a
Collateral Source (1975-76)	.031 (.039)	.032 (.039)	a
Prior Approval or Modified Prior	.048 (.074)	.054 (.075)	a
Flex Rating	.038 (.087)	.047 (.088)	a
Use and File/File and Use	.047 (.072)	.055 (.073)	a
Mutual	-.333* (.057)	-.357* (.058)	-.319* (.057)
Reciprocal	-.019 (.088)	-.027 (.090)	-.013 (.089)
Lloyds	-.169 (.378)	-.186 (.439)	-.369 (.384)
Log National Premiums Written	-.110* (.007)	-.113* (.007)	-.107* (.007)
Log State Aggregate Income	.022 (.016)	.021 (.016)	a
Log Treasury-Bill Rate	-.181 (.110)	-.159 (.112)	-.046 (.064)
R ²	.253	.264	.257
Detailed reform variables:			
Damages	-.132* (.038)	-.132* (.039)	-.250* (.069)
Collateral Source	-.061 (.043)	-.057 (.044)	-.039 (.077)
Attorney Fees	-.123* (.055)	-.127* (.056)	-.073* (.110)
Other reforms	-.054 (.042)	-.062 (.043)	-.201* (.067)

NOTE.—Standard errors are in parentheses.

^a Variables were omitted from the fixed effects regressions since they did not vary within the state.

* Significant at the 95 percent confidence level, one-tailed test.

placing the aggregative liability reform variable by a detailed set of four liability reform measures (see the bottom panel of Table 6). The Damages reform variable is consistently the most influential, as this variable alone accounts for a 13 percent decrease in the loss ratio in the ordinary least squares and weighted least squares estimates and a 25 percent decrease in the loss ratio for the fixed effect estimates. The other influences are more inconsistent, as the attorney fee provisions are statistically significant in the ordinary least squares and weighted least squares results, but not in the fixed effect results. The opposite pattern is displayed by the Other Reforms variable, and the Collateral Source variable is never statistically significant.

If it is in fact the liability reform efforts and, in particular, the damages cap reforms that are responsible for the increased profitability of medical malpractice insurance, then one would not expect these reforms to have a uniform effect throughout the entire loss ratio distribution. In particular, one would expect the largest effects to be exhibited at the upper quantiles of the distribution, as was the case in the Michigan and Wisconsin experience.

To explore this possibility more formally, we will utilize a quantile regression model based on the work of Koenker and Bassett. In particular, instead of focusing on the value of the loss ratio, the emphasis will instead be on whether the loss ratio lies within a particular quantile of the loss ratio distribution. In particular, the quantile regressions estimate the effect of a vector of explanatory variables x on the conditional distribution of the loss ratios, which we will designate by LR. Following Koenker and Bassett, we will assume that the τ th quantile of LR given x is linear and can be characterized by

$$\text{Quant}_\tau(\text{LR} | x) = \beta'_\tau x, \quad (6)$$

where β_τ is the pertinent vector of coefficients for the τ th quantile. Thus, this analysis enables one to determine the differential effect of the explanatory variable vector x on loss ratios at different quantiles.²⁷

²⁷ The quantile regressions were estimated using an estimator that can be characterized by

$$\text{Min}_\beta \frac{1}{n} \sum_{i=1}^n [\tau \rho(\text{LR}_i \geq \beta' x_i) + (1 - \tau) \rho(\text{LR}_i < \beta' x_i)] |\text{LR}_i - \beta' x_i|,$$

where n is the sample size, i designates firm i in the sample, and ρ is an indicator function that takes on a value of 1 if the event characterized by the specified inequality within eq. (7) holds and a value of 0 if it does not. Following Roger Koenker & Gilbert Bassett, Jr., *Regression Quantiles*, 46 *Econometrica* 33–50 (1978); and Roger Koenker & Gilbert Bassett, Jr., *Robust Tests for Heteroscedasticity Based on Regression Quantiles*, 50 *Econometrica* 43–61 (1982), we also assume that the conditional density of y given x in the τ th quantile is independent of x . To obtain the value of the asymptotic standard errors, we utilized a bootstrap estimator. See Gary Chamberlain, *Quantile Regression, Censoring, and the Struc-*

TABLE 7
ESTIMATES OF THE EFFECTS OF REFORMS QUANTILE REGRESSION ON LOSS RATIOS
(Bootstrap Standard Errors Are in Parentheses)

VARIABLE	QUANTILE				
	10%	25%	50%	75%	90%
Intercept	.149* (.027)	.343* (.057)	.522* (.059)	.925* (.108)	1.492* (.457)
Loss Ratio _{t-1}	.007* (.014)	.076* (.033)	.241* (.050)	.674* (.138)	2.141* (.306)
Reform	-.011 (.011)	-.057* (.017)	-.119* (.021)	-.313* (.045)	-.678* (.200)
Ceiling on Recoveries (1975-76)	-.005 (.013)	-.005 (.015)	.003 (.015)	-.016 (.033)	-.073 (.144)
Attorney Fees (1975-76)	0.14 (.010)	-.005 (.011)	-.011 (.013)	-0.85* (.029)	-.351* (.130)
Collateral Source (1975-76)	-.013 (.009)	-.015 (.013)	-.005 (.013)	-.007 (.029)	.080 (.131)
State Aggregate Income	2.2E-7* (4.4E-8)	2.5E-7* (5.6E-8)	1.5E-7* (6.6E-8)	3.0E-7* (1.4E-7)	2.7E-8* (6.8E-7)
Treasury-Bill Rate	-.002 (.004)	-.003 (.006)	.005 (.006)	-.008 (.015)	.024 (.050)
Lloyds	-.017 (.521)	-.026 (1.060)	.215 (.890)	3.093* (1.310)	3.933* (1.630)
Mutual	-.047* (.011)	-.097* (.015)	-.118* (.022)	-.153* (.043)	-.272* (.161)
Reciprocal	.013 (.022)	.002 (.024)	-.050* (.028)	-.158* (.054)	-.589* (.168)

* Significant at the 95 percent confidence level, one-tailed test.

Table 7 reports the striking result of the quantile regression models, where only the estimates for the aggregative liability reform variable are reported.²⁸ Results are reported for five different quantiles—10 percent, 25 percent, 50 percent (the median), 75 percent, and 90 percent. The liability reform variable is not statistically significant at the 10 percent quantile, which is at the bottom of the loss ratio distribution. It is statistically significant in all other cases, and the magnitude of the coefficient steadily rises, starkly so at the 90 percent quantile, where the estimates imply that the tort liability reform reduces the absolute magnitude of the loss ratio by -0.68. The dramatic escalation of the effect of liability reform on loss ratios based on the quantile regression results suggests

ture of Wages (discussion paper, Harvard Inst. Econ. Res. 1991). The particular program used was a linear programming routine developed by William Evans at the University of Maryland based on Koenker & Bassett, Regression Quantiles, *supra*.

²⁸ Because of convergence problems, two modifications were necessary to make estimation of the equation feasible. First, the variables initially expressed in log form were replaced with the actual values, thereby creating larger differences between quantiles. Next, it was not feasible to estimate an equation that also included some of the less important variables in the model. The variables omitted from the equation include National Premiums Written and the rate regulation dummy variables.

that liability reforms are particularly influential in dampening the upper right tail of the loss ratio distribution.

Moreover, the pattern of quantile regression results is also instructive in indicating that this phenomenon is not simply a regression to the mean effect. If that were the case, then one would expect there to be a significant jump in the loss ratios in the lower quantiles. Instead, the pattern is one of no significant effects followed by steadily rising influences, as opposed to a pattern of estimates in which the absolute values of the coefficients assumed a V-shaped pattern, as would be the case in the regression to the mean situation. Overall, the effect of liability reform appears to be quite substantial and to have dramatically transformed the profitability of firms which otherwise would have been at the high end of unprofitability. It is also noteworthy that in the quantile regression results in Table 7, one of the 1975-76 reform variables is also statistically significant in two instances. The attorney fees reforms have a negative effect on loss ratios for both the seventy-fifth percentile and the ninetieth percentile, where these influences range from one-fourth to half as large as the effect of the 1980s reform variable.

Some of the other variables, such as the lagged loss ratio and the organizational form variables, also appear to have a larger magnitude of influence as one moves from the lower to the higher quantiles. Firms at the upper end of the loss ratio distribution appear to be much more sensitive to wider swings in behavior than firms at the lower end, where this pattern is true not only for the influence of liability reform but some other variables as well.

V. THE EFFECT ON LOSSES AND PREMIUMS

The decrease in the loss ratio implies either that loss levels decreased, that premiums increased, or that there was a change in the growth of both of these rates sufficient to lead to a decrease in the level of losses relative to premiums. If the tort liability reform mechanism is operative, then one would expect the primary effect of tort liability to be exerted through losses rather than premiums. It may be that both of these increased, but the growth in losses should be less than the growth in premiums if the tort liability reforms restrain liability costs. In long-run market equilibrium, one would expect the marginal profitability of policies to be identical across states. However, this adjustment process is not immediate, and to the extent that one views the loss ratios before the reform era as being aberrationally high, then one might not expect a full pass-through of the reduction in losses to occur through a reduction in premiums.

The focus will be on regression equations involving the log of losses

and the log of premiums, where the logarithmic transformation will limit the influence of outliers. Each of these equations takes an autoregressive form and is similar in character as

$$\begin{aligned} \text{Log Losses}_{it} = & \alpha_3 + \beta_3 \text{Log Losses}_{it-1} + \Psi_3 \text{Log Premiums}_{it} \quad (7) \\ & + \gamma_3 \text{Reform}_{it} + \sum_{j=1}^N \delta_j X_{jit} + \epsilon_{3it}, \end{aligned}$$

and

$$\begin{aligned} \text{Log Premiums}_{it} = & \alpha_2 + \beta_2 \text{Log Premiums}_{it-1} + \gamma_2 \text{Reform}_{it} \quad (8) \\ & + \sum_{j=1}^N \delta_j X_{jit} + \epsilon_{2it}. \end{aligned}$$

The only difference is that the loss equation also includes the contemporaneous value of premiums earned to control for the size of the insurance market for which the losses are pertinent. Although the value of premiums in year t is included in equation (7), which is the loss equation for year t , these values are not simultaneously determined. The loss values are those ultimately charged to the policy written in year t , often several years later. The value of premiums is always predetermined before any losses are generated and, as a consequence, can be treated as exogenous.

As in the case of loss ratio results, three sets of estimates will be presented: ordinary least squares, weighted least squares, and fixed effects. Table 8 reports the estimates of the log loss equation, and Table 9 reports estimates for the log premium equation.

The Reform variable is statistically significant in all specifications. Liability reform on average reduces losses in the short run by 22–23 percent based on the ordinary least squares and weighted least squares results and by 48 percent based on the fixed effects results. Most of this effect is captured by the detailed reform variable pertaining to damages limitations, which accounts for a 16 percent reduction in losses for the first two specifications and a 29 percent reduction in losses in the fixed effects equation. The ultimate long-run effects of liability reforms are almost double the value of the short-run effects, as the total reform effect is 40 percent (ordinary least squares), 43 percent (weighted least squares), and 87 percent (fixed effects). The long-run effects appear to be implausibly large for the fixed effects results. Controlling for fixed state-specific differences controls for the influence of different jurisdiction and legal climates that one might not wish to abstract from in determining the actual effects liability reforms will have. The long-run estimates also presuppose the underlying stability of the lagged relationship.

TABLE 8
REGRESSION ESTIMATES OF LOG INCURRED LOSS EQUATIONS

	Ordinary Least Squares	Weighted Least Squares	Fixed Effects
Intercept	.199 (.244)	.184 (.245)	. . .
Log Losses Incurred _{t-1}	.458* (.008)	.470* (.008)	.451* (.008)
Log Premiums Earned _t	.448* (.011)	.432* (.011)	.448* (.011)
Reform	-.217* (.039)	-.227* (.039)	-.475* (.051)
Ceiling on Recoveries (1975-76)	-.081* (.042)	-.080* (.042)	^a
Attorney Fees (1975-76)	-.024 (.036)	-.023 (.036)	^a
Collateral Source (1975-76)	.068* (.037)	.070* (.038)	^a
Prior Approval or Modified Prior	.056 (.070)	.058 (.071)	^a
Flex Rating	.071 (.083)	.078 (.083)	^a
Use and File/File and Use	.050 (.069)	.054 (.069)	^a
Mutual	-.311* (.054)	-.326* (.055)	-.292* (.054)
Reciprocal	.078 (.085)	.070 (.086)	.104 (.086)
Lloyds	.181 (.361)	.206 (.418)	-.026 (.366)
Log National Premiums Written	-.011 (.010)	-.008 (.010)	-.002 (.010)
Log State Aggregate Income	.105* (.017)	.108* (.017)	^a
Log Treasury-Bill Rate	.047 (.060)	.057 (.061)	-.028 (.061)
R ²	.782	.780	.784
Detailed reform variables:			
Damages	-.155* (.037)	-.156* (.037)	-.293* (.066)
Collateral Source	-.092* (.041)	-.092* (.042)	-.097 (.073)
Attorney Fees	-.125* (.053)	-.127* (.053)	-.068 (.104)
Other reforms	-.057 (.041)	-.066 (.041)	-.235* (.063)

NOTE.—Standard errors are in parentheses.

^a Variables were omitted from the fixed effects regressions since they did not vary within the state.

* Significant at the 95 percent confidence level, one-tailed test.

TABLE 9
REGRESSION ESTIMATES OF LOG EARNED PREMIUMS EQUATIONS

	Ordinary Least Squares	Weighted Least Squares	Fixed Effects
Intercept	-3.044* (.173)	-3.163* (.174)	a
Log Premiums Earned _{t-1}	.758* (.005)	.756* (.005)	.754* (.005)
Reform	-.046 (.028)	-.045 (.028)	-.124* (.037)
Ceiling on Recoveries (1975-76)	-.072* (.030)	-.074* (.031)	a
Attorney Fees (1975-76)	-.035 (.026)	-.039 (.026)	a
Collateral Source (1975-76)	.080* (.027)	.082* (.027)	a
Prior Approval or Modified Prior	.009 (.051)	-.001 (.051)	a
Flex Rating	.071 (.060)	.061 (.060)	a
Use and File/File and Use	.007 (.050)	-.002 (.050)	a
Mutual	.128* (.039)	.141* (.040)	.134* (.039)
Reciprocal	.319* (.062)	.310* (.062)	.339* (.062)
Lloyds	.806* (.261)	.865* (.303)	.801* (.266)
Log National Premiums Written	.239* (.006)	.244* (.006)	.244* (.006)
Log State Aggregate Income	.212* (.012)	.215* (.012)	a
Log Treasury-Bill Rate	.008 (.044)	.017 (.045)	-.007 (.044)
R ²	.876	.876	.876
Detailed reform variables:			
Damages	-.033 (.027)	-.033 (.027)	-.057 (.048)
Collateral Source	-.033 (.030)	-.038 (.030)	-.077 (.053)
Attorney Fees	.018 (.038)	.024 (.038)	.028 (.076)
Other reforms	-.011 (.029)	-.011 (.030)	-.058 (.046)

NOTE.—Standard errors are in parentheses.

a Variables were omitted from the fixed effects regressions since they did not vary within the state.

* Significant at the 95 percent confidence level, one-tailed test.

The detailed 1980s reform coefficients are most influential for the loss equation, as damages limits, attorney fees provisions, and Other Reforms have a negative and statistically significant effect in one or more equations. The Damages variable is consistently influential, as in the case of the loss ratio results. In particular, the Attorney Fees variable is statistically significant and negative in the first two loss equation specifications, but not in the fixed effects results, whereas the opposite pattern is observed for the Other Reforms variable, as was the case in Table 6. One difference from the loss ratio effects is that the Collateral Source variable also has a statistically significant negative effect in the first two specifications, but not in the fixed effects results. The main implication of these results is that the findings are consistent with the mechanism of tort liability reform being a reduction in losses as opposed to simply a change in the liability insurance environment to permit higher insurance prices. Moreover, the Damages Limitation variable is consistently the most influential in affecting losses, as was the case for loss ratios.

The two 1970s reform variables that are statistically significant have opposite signs. Recovery ceiling provisions have a negative effect on losses, and collateral source rules a positive effect. These influences may be spurious effects reflecting omitted state-specific differences. The effects of the liability reform measures on the log of earned premiums, as estimated in Table 9, do not indicate any statistically significant influences of the 1980s reforms apart from one negative overall reform influence in the fixed effects equation. The 1970s reform measures continue to exhibit mixed effects. Overall, there is no clear-cut evidence of an influence of liability reform on premiums apart from some potential modest reduction in premiums that is not robust. The main mechanism by which the loss ratio has been reduced has been through a decrease in the losses associated with medical malpractice insurance, which is consistent with what one would expect from a successful reform effort.

VI. CONCLUSION

This detailed examination of effect of medical malpractice reforms on individual firms writing medical malpractice insurance indicated that these efforts had a rather dramatic effect. The two case studies of Michigan and Wisconsin that had targeted reform efforts consisting primarily of damages limitations indicated a clear-cut shift in the performance of liability insurance. In particular, there was a change in the profitability of medical liability insurance over time, increased profitability relative to automobile insurance, and increased profitability viewed from a perspective of a differences-in-differences estimator. Moreover, these effects

were not uniform. Instead, there was a much larger downward shift in the upper right tail of the loss ratio distribution. The firms that would have been most unprofitable benefited most from the damages cap reforms.

Extension of this analysis to the national reform level to consider the state reform efforts of 1985, 1986, and 1987 using a national data set of every liability insurance firm writing coverage in each of the 50 states reinforced these conclusions. The loss ratios in these states were at very high levels, with losses in excess of premiums before the reform efforts. The liability reforms on average and the damages cap provisions in particular contributed to a substantial downward shift in the loss ratios, which implies a rise in the profitability of insurance. In particular, 0.2 of the 0.5 drop in loss ratios from 1985 to 1991 for the sample was attributable to the short-run effect of liability reforms, with the long-run effect of liability reforms accounting for 0.4 of the 0.5 drop. Although other factors no doubt were operative, such as changes in underwriting practices and shifts in interest rates, much of the increased profitability of insurance can be attributed to the advent of liability reforms.

A detailed examination of the effect of these reforms is consistent with the mechanisms one would expect from a successful reform effort. In particular, the influence of the liability reform variables on loss ratios is accompanied by a comparable pattern of influence on loss levels. In contrast, premiums seem only modestly affected by the liability reform measures, so that the main mechanism has been to reduce the losses associated with policies as opposed to raising the prices that can be charged.²⁹

Perhaps the most instructive results were those that went beyond the conventional regression findings that focus on average performance throughout the sample. In particular, examination of the shift in the loss distribution and the quantile regression results for the national sample indicated that the effect of the liability reform measures was not uniform throughout the population of firms. The primary effect of the liability reforms was to generate a leftward shift in the loss ratio distribution. The firms that were outliers on the unprofitable upper right tail of the loss ratio distribution benefited most from the liability reform measures.

Although any judgment regarding the social desirability of such changes requires a much more detailed assessment than that offered here, the character of these influences is quite consistent with the avowed objectives voiced by many proponents of liability reform. Before the

²⁹ Because none of these estimates control for the quantity of insurance purchased, one should be careful of the nature in which such conclusions are drawn. For these reasons, the best measure of the effect of liability reforms is to examine the loss ratio, which serves as a measure of the inverse of the ex post price of insurance.

reform efforts, insurers faced not only a problem associated with substantial unprofitability but also a situation of considerable uncertainty. Liability reform not only enhances profitability but also diminishes uncertainty by having its greatest effect on the upper right tail of the loss ratio distribution. It is likely that this is the type of uncertainty—downside risk—that is the primary concern of firms. The risk of being highly profitable is generally not a major issue, but the chance that a firm might be very unprofitable and may even become insolvent is much more salient. Medical malpractice liability reform consequently generated a variety of diverse effects that one would expect from a sound reform agenda.