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Dynamics of the Market for Medical Malpractice Insurance

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Abstract

Public attention has been directed recently at the market for medical malpractice insurance, yet disagreement persists over whether this market has changed and, if so, what has caused this change. In this study, we examine factors that affect the market for this insurance, including the growth in premiums, losses, and investment earnings, and loss variability. Our analysis suggests that there was significant deterioration in the market for medical malpractice insurance beginning in 1998 and culminating in 2001. We conclude that insurers' losses are the primary driver of the market deterioration during the period 1998 through 2003.

Introduction

Medical malpractice insurance is coverage for medical professionals for liability resulting from claims of professional negligence. The market for medical malpractice insurance is important because it affects the availability and cost of medical malpractice liability insurance. If the market performs poorly over an extended period of time, medical malpractice insurance may become unaffordable or unavailable, resulting in physicians discontinuing needed high-risk medical services, continuing to practice but with limited liability protection, or engaging in defensive medicine resulting in higher medical costs.[1] Currently, there is considerable debate among the stakeholders involved in medical malpractice insurance regarding the performance and underlying stability of the medical malpractice insurance market.

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[1] The Governor's Select Task Force on Healthcare Professional Liability Insurance (January 29, 2003), issued by the Florida Department of Health and Human Services, reports on page vi of the Executive Summary that as insurance premiums increase some physicians carry minimum limits of $250,000 while others are going "bare" and carrying no liability limits at all. See also Albert and Adams (2002).

The American Medical Association (AMA) reports that 21 states were considered to be in a medical liability crisis, based on factors such as the availability of liability coverage, the number of insurers writing policies, the cost (and rate of increase of the cost) of insurance, and the number of insurers leaving the market.[2,3] Albert (2002) reports that physician groups and advocates also cite rising jury awards as the primary reason for affordability problems, with higher claims leading to higher premiums. Insurers cite increases in claim frequency, severity, and uncertainty of jury awards, competition in the 1990s that resulted in underpricing premiums, and decreases in market rates leading to insufficient loss reserves as factors contributing to insurer profitability problems that translated into availability problems for physicians.[4] Plaintiff attorneys state that rising premiums are a result of decreased investment income, insurer management inefficiency, or even greed as reported in Treaster (2002). The purpose of this study is to identify whether the medical malpractice insurance market changed significantly over the period from 1993 to 2002 and, if so, determine the effect of the changes on the stability of this market.

We proceed as follows in this study. In the "A Review of the Literature" section, we review the research that analyzes medical malpractice insurer data from the 1970s and 1980s and that addresses general liability crises. The latter is included because the rich literature surrounding the causes of the underwriting cycle in general liability lines allows us to consider causes for the very similar behavior that occurs in the market for medical malpractice insurance. In the "Results" section, we analyze medical malpractice insurer performance measures, investigate the stability of the market, and determine whether it actually has deteriorated as some have stated. We analyze the causes of the changes in market performance in the "Causes of the Decline in the Medical Malpractice Insurance Market" section, and conclude our study and discuss the implications of our findings in the "Conclusions" section.

A REVIEW OF THE LITERATURE

The Medical Malpractice Market of the 1970s and 1980s

The first identified major change in the market for medical malpractice insurance occurred in the 1970s.[5] In this period, many commercial insurers withdrew from the market, with many of those being large insurers that supplied over half of the

[2] Additional factors considered by the AMA are other geographical, economical, and historical factors such as a state's history on tort reform and existing shortages of providers (AMA, 2004).

[3] AMA, released February 14, 2006. "Tennessee joins states in medical liability crisis," available at http://www.ama-assn.org/ama/pub/category/15992.html, and "AMA refutes bogus medical liability study," May 8, 2006, available at http://www.ama-assn.org/ama/pub/category/16239.html.

[4] Statement of the Physician Insurers Association of America (PIAA) presented by Lawrence E. Smarr, president of PIAA on June 12, 2002, before the Subcommittee on Commercial and Administrative Law, Committee on the Judiciary, U.S. House of Representatives. The topic of this statement was "Does Limitless Litigation Restrict Access to Health Care?"

[5] Beginning with 1935 and ending in 1975, 80 percent of all medical malpractice litigation was filed between 1971 and 1975 per the AMA (1984).

market capacity.[6] Researchers offer several factors that may have contributed to this withdrawal, including the growth of medical services, increased litigiousness, and the expansion of common law doctrine. In response, some states imposed caps on damages and collateral source rules after 1975, which appears to have significantly reduced the severity of claims.[7]

A second noticeable change in this market is identified in the mid-1980s, in which liability insurance premiums increased significantly and insurance became more difficult to obtain as shown in Born and Viscusi (1998). Researchers identified several factors that contributed to this change. D'Arcy (1986) and Born and Viscusi argue that the altered market was caused, in part, by the overturning of the 1970s tort reforms, increasing claim frequency, and the development of health care cost containment programs. In addition, researchers argue that policies were underpriced and reinsurance was more difficult to obtain.[8] Farber and White (1991) and Quinn (1998) identify other factors contributing to the 1980s market. These factors are the quality of medical care received, the extent of communication between patient and physician regarding their medical care, and the increase in defensive medicine by physicians who desire to avoid the negative reputational effects of medical malpractice claims. Cummins and Danzon (1994) conclude that the change in the medical malpractice market in the 1980s was caused by a variety of factors: decreased interest rates, increased expectations of losses, changes to liability reforms, and insurers strengthening their reserves.

Underwriting Cycles in General Liability

A great deal of research has been performed on the causes of the underwriting cycle in general liability lines, with many explanations proposed and examined. Because medical malpractice insurance behaves similarly, we survey this literature to explore possible explanations of the behavior of the market for medical malpractice insurance. In several studies, researchers provide evidence current premiums are explained by insurers' past surplus even after controlling for future losses.[9] A few researchers have suggested that premiums are positively related to both underwriting expenses and uncertainty, as a result of a change in expectations.[10] Numerous researchers have found support for the idea that there is an inverse relationship between current

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[6] See Steves, McWhorter, and Fisher (1979). Nye and Hofflander (1987) provide a comprehensive summary of the 1970s crisis, as well as an overview of the state of malpractice litigation beginning in the 1930s.

[7] Danzon (1984) discusses the contributing factors and notes that the findings regarding caps on damages and collateral source rules must be viewed with caution due to the relatively short time period examined after reform implementation.

[8] See D'Arcy (1986), Born and Viscusi (1998), Nye and Hofflander (1987), and Berger, Cummins, and Tennyson (1992). Nye and Hofflander (1987) contend that underpricing is the main cause of these crises and occurs because medical malpractice insurers are pricing their products using incomplete information and regulation of pricing of medical malpractice products is ineffective.

[9] See Winter (1991), Gron (1994), Cummins and Danzon (1992), and Niehaus and Terry (1993).

[10] For the development of this hypothesis, see Lai and Witt (1990, 1992). Fung et al. (1998) find support that premiums are positively related to uncertainty but not to underwriting expenses.

premiums and past surplus charges, attributable to capacity constraints, and/or capital market imperfections.[11]

Some argue that changes in interest rates exacerbate cycles because fluctuations in future interest rates may result in mispriced premiums. Several researchers have found an inverse relation between interest rates and premiums.[12] Another hypothesis is that current premiums are hypothesized to be explained by past losses after controlling for anticipated future losses.[13] Still another explanation is that underwriting errors and cycles are caused by external events and factors outside of the insurers' control, including regulatory lags, policy renewal lags, accounting factors, and institutional factors.[14] Further, Harrington and Danzon (1994) find that the fastest growing firms had the largest loss-estimation errors, providing support that excessive risk taking and the winner's curse both contribute to price cutting in a soft market and, hence, affect underwriting cycles.

Gron and Winton (2001) provide that another possible explanation of these cycles is the existence of risk overhang. Risk overhang is the exposure to large losses occurring at a time in which the insurer has depleted capital, thus affecting the insurer's risk aversion. Previous research suggests that business lines with a large amount of risk overhang—more likely liability lines in which there is a greater overhang—experience longer market disruptions.

Lai et al. (2000) develop and test a model to provide a broader explanation of determinants of cycles and crises in the general liability market. Their analysis brings together ideas from previous studies on general liability cycles and adds expectations of changes in corporate income as an explanatory factor. Specifically, their theoretical model purports that liability insurance crises are the result of increased expectations of both supply and demand, as well as changes in expectations regarding future losses, surplus, and interest rates.

Based on their theoretical model, Lai et al. (2000) examine empirically the explanations of a liability crisis that they identify between 1984 and 1986. The authors find that the change in the growth rate of premium income is explained by the change in the growth rate of losses, the variance of the growth rate of losses, the change in the growth rate

[11] See, for example, Fung et al. (1998), Winter (1988), and Gron (1994).

[12] Fung et al. (1998) observe an inverse relationship between premiums and interest rates, with the variability of these rates being more important in long tail lines, and losses more important in short tail lines. See also Grace and Hotchkiss (1995), Doherty and Kang (1988), and Doherty and Garven (1995). Fields and Venezian (1989) find a positive relationship between unanticipated changes in interest rates and the profitability of insurers, whereas Haley (1993) finds over the long term there is a relationship between underwriting margins and short-term interest rates.

[13] See Venezian (1985), Niehaus and Terry (1993), and Fung et al. (1998). Berger (1988) posits that the underwriting cycle is a result of supply shifts as surplus changes when firms' profits change. In the alternative, Cummins (1990) finds that current premiums are explained by future losses and not by past information.

[14] Venezian (1985) asserts that the primary causes of errors in decision making are accounting and regulatory systems imperfections. Similarly, Lamm-Tenant and Weiss (1997), Fung et al. (1998), and Cummins and Outreville (1987) add other external factors such as data collection and regulatory and policy renewal lags, and find these contribute to underwriting cycles.

of expenses, and the variance of the growth rate of expenses.[15] They also test the relationship between the growth rate of premium income and five control variables that capture surplus, size, reinsurance, liquidity, and organizational structure. They find that the ratio of premiums to surplus is negatively related to premiums, whereas size, as proxied by the natural log of total assets, is positive and significantly related to changes in premiums. They conclude that increases in the mean and dispersion of losses and expenses explain the increases in premiums.

The authors examine the relation between premium and investment income by examining the difference in the growth rates of net investment gain or loss in the different years for the "other liability" line. They also look at the standard deviation of the growth rate in losses, a proxy for uncertainty, during these two periods. They find that there are periods in which the average growth rates of losses and expenses are significantly higher than in other years. The standard deviations of the growth rate in losses and the growth rate in investment gain or loss are, as expected, higher during a period of market deterioration.

Lai et al. (2000) perform a comparison of underwriting experience and overall operating costs to test the greed and mismanagement hypotheses and find no support for these hypotheses. The authors conclude that the market deterioration of the 1980s is explained by changes in expectations due to unanticipated changes in losses, expenses, and interest rates.

In our analysis, we rely heavily on the methodology of Lai et al. (2000). First, we use losses incurred as one of the main performance variables to be tested in all of our analyses instead of losses paid. Using losses incurred takes into account the fact that insurers price policies, in part, on expected future losses and this variable allows us to test the "change in expectations" hypothesis in medical malpractice insurance. Second, the majority of our tests involve examining changes in growth rates across time. We use Lai et al.'s methodology of calculating these changes in growth rates with one exception; we use geometric growth rates instead of the arithmetic growth rates.[16] Lastly, the regression model that we use to analyze the causes of the medical malpractice market deterioration found is based on the regression model that Lai et al. first developed theoretically and then tested empirically. We have made some necessary changes to the regression model to conform to the needs of this study. The specific methodology used and any changes made are discussed in detail in each relevant section.

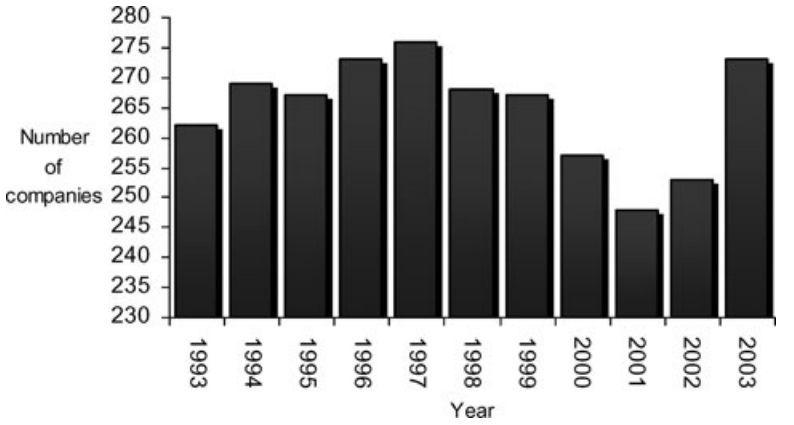
RESULTS

Several questions arise when examining insurer performance in the medical malpractice industry. From the consumer's viewpoint, it is commonly believed that a critical point occurs in an insurance market when insurance becomes unaffordable and/or unavailable. On the insurer's side a critical point occurs when net income

[15] The authors note that in their first model with all the variables included they find a high correlation between the mean and variance of losses; therefore, they drop the mean to form a second model and the variance becomes significant and positive as expected.

[16] Specifically, we examine growth rates in the sections "Changes Across Time," "Examination of Expectations," "Examination of the Management Efficiency Hypothesis," and "Analysis of Causes For Medical Malpractice Market Deterioration."

FIGURE 1
Number of Companies Writing Positive Direct Premiums, 1993–2003



Source: NAIC database.

from premiums and investments are insufficient to cover the costs of claims over an extended period of time. Using financial data from 1993 to 2003 from the National Association of Insurance Commissioners (NAIC) for all insurers writing medical malpractice insurance, we examine the number of insurers writing medical malpractice insurance and the relationship between growth rates of their premiums and losses, variance of losses, and investment income. Our primary purpose is to examine the stability of the market for medical malpractice insurance by looking at changes in the market. Our secondary purpose is to examine whether these changes result in a deterioration of the market.

We assume that under normal, equilibrium market conditions, the larger the number of participants in the market and the larger the supply of insurance, the greater its availability. Using the NAIC data, we trace the number of companies reporting positive direct premiums written on a national basis from 1993 to 2003 and find the market has changed over the years in terms of the number of participating insurers. We show the number of insurers reporting positive direct premiums written in Figure 1. During the period 1993–2003, the peak number of participants was 276 in 1997 and the number of insurers writing positive direct premiums written fell to 248 in 2001. However, the market began to rebound in 2002 to 253 and continued to increase to 273 in 2003.

Identification of Market Instability

Bivariate Granger Causality. There is some debate as to whether higher losses, fueled by higher jury awards, are driving higher premiums, which is consistent with the views expressed by insurers, or whether premiums are increasing while losses are stable, with insurers taking advantage of a contracting supply, which is a view expressed by plaintiff attorneys. Previous research that addresses the explanations of the insurance cycle for medical malpractice insurance examines the relation between premiums and losses but does not address whether premiums lead losses or if losses lead premiums.

We use bivariate Granger causality tests to determine whether past losses predict premiums or, in the alternative, whether past premiums predict current losses. An advantage of this estimation technique is that we can estimate directionality of the relation between premiums written and losses.[17] The basic idea behind Granger causality is that we estimate and compare the strength of the explanatory power of both lagged direct losses in explaining net premiums written and lagged net premiums written in explaining direct losses.[18]

Because Granger causality tests may be sensitive to the number of the lags chosen, we estimate the model using 2-, 3-, 4-, 5-, and 6-year lags. We examine the longer lags to account for claim development; the shorter lags are used to account for current unexpected developments that may influence premium prices. The following hypotheses are tested.

Hypothesis 1: Current year net premiums written are predicted by past direct losses incurred.

Hypothesis 2: Current year direct losses incurred are predicted by past net premiums written.

We test these hypotheses by estimating the following equations:

$$NPW_t = \alpha + \sum_{m=1}^{M} \lambda_m NPW_{t-m} + \sum_{m=1}^{M} \delta_m DLI_{t-m} + \eta_t, \tag{1}$$

$$DLI_t = \varsigma + \sum_{m=1}^{M} \varphi_m DLI_{t-m} + \sum_{m=1}^{M} \omega_m NPW_{t-m} + \upsilon_t, \tag{2}$$

where *NPW* is net premiums written, *DLI* is direct losses incurred, *M* is the number of lags, and *t* is the ending year being examined.

Using firm-level data for each year and both a *F*-distributed test statistic and a χ^2-distributed test statistic, we test the coefficients on the direct losses incurred lags in Equation (1) to see whether these direct losses incurred explain net premiums written.[19] Similarly, we test whether lagged values of net premiums written explain direct losses in Equation (2).

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[17] The Granger causality method was developed by Granger (1969). This method is used to determine in which direction is the stronger relation between two time series. The implication is that the stronger directionality is therefore the more likely causal relation.

[18] Granger causality analysis has been used to examine causal relationships between many different factors including income and government expenditure, as well as stock prices and different macroeconomic variables including exchange rates, budget deficits, interest rates, and supply and demand to name a few.

[19] The predictive ability of direct losses paid on net premiums written, and vice versa, was also analyzed and the results were the same as for direct losses incurred. The results for direct losses paid are available upon request.

TABLE 1
Granger Causality Tests for Direct Losses Incurred and Net Premiums Written

$$NPW_t = a + \sum_{m=1}^{M} \lambda_m NPW_{t-m} + \sum_{m=1}^{M} \delta_m DLI_{t-m} + h_t \qquad \text{Test 1: } H_0 : \delta_1 = \delta_2 = \delta_3 = \cdots = \delta_M = 0 \qquad (1)$$

$$DLI_t = \varsigma + \sum_{m=1}^{M} \jmath_m DLI_{t-m} + \sum_{m=1}^{M} \upsilon_m NPW_{t-m} + \upsilon_t \qquad \text{Test 2: } H_0 : \upsilon_1 = \upsilon_2 = \upsilon_3 = \cdots = \upsilon_M = 0 \qquad (2)$$

	Test 1 Test of Direct Losses Incurred in Explaining Net Premiums Written 2-Lag Model		Test 2 Test of Net Premiums Written in Explaining Direct Losses Incurred 2-Lag Model		R^2 2-Lag Model	
Year	F-Distributed Test Statistic	χ^2-Distributed Test Statistic	F-Distributed Test Statistic	χ^2-Distributed Test Statistic	Equation (1)	Equation (2)
1999	66.6471*	134.1936**	297.5367*	599.0887*	91.76%	82.74%
2000	684.5552*	1,378.848**	336.7568*	678.3093*	94.02%	82.73%
2001	9.6572*	19.4585*	1.8974	3.8231	81.03%	74.16%
2002	143.1027*	288.3541**	870.2217*	1,753.5098*	89.36%	91.98%

* Indicates that the hypothesis of zero coefficients is rejected at the 5% level of significance.

Specifically, Granger causality tests examine whether one variable is significantly predicted by the lagged variable, after taking into account the effect of lagged values of the dependent variable. In the case of (1), we test whether premiums are predicted by lagged direct losses incurred after controlling for lagged values of premiums. We perform the test of the hypotheses by comparing the sum of squared residuals from two models: the unrestricted model, as specified in Equations (1) and (2), and the restricted versions of these models, which are Equations (1) and (2) that include only the lagged dependent variable.[20]

We use the residuals of these models to calculate two test statistics, an F-distributed test and a χ^2 distributed test, which are asymptotically equivalent, to determine if one variable "Granger causes" the other:

$$\text{Test 1:} \quad S_F = \frac{(SSE_2 - SSE_1)/M}{SSE_1/(N + 2M - 1)} \sim F_{p,N-2M-1}$$

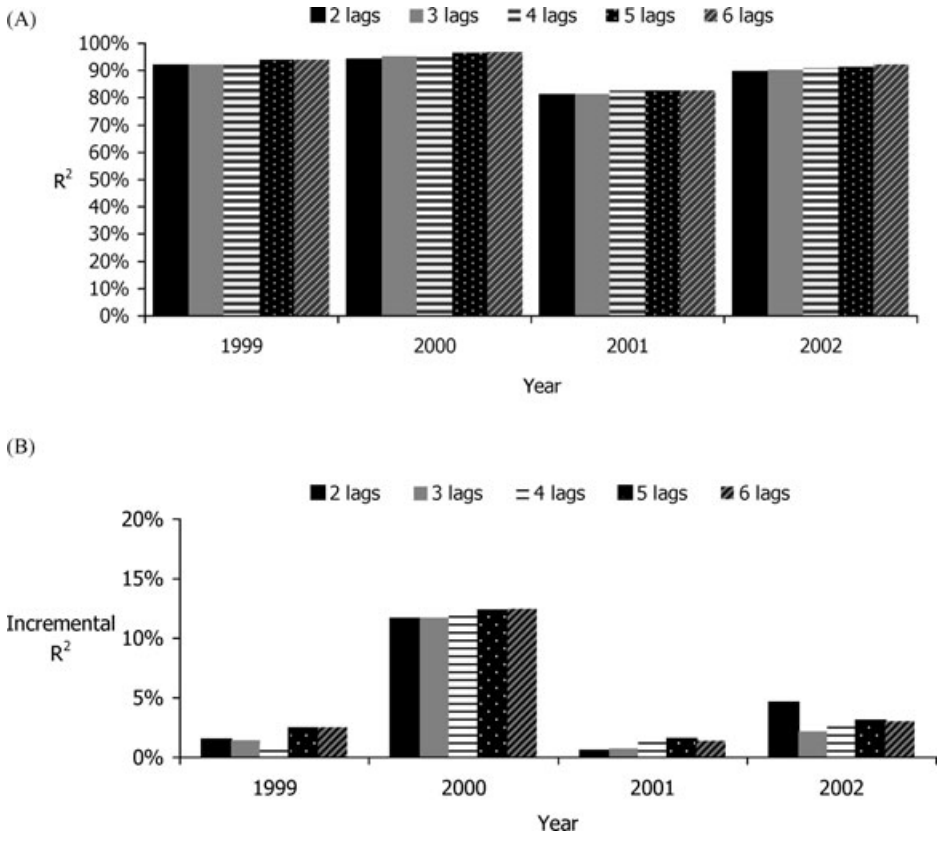
$$\text{Test 2:} \quad S_{\chi^2} = \frac{N(SSE_2 - SSE_1)}{SSE_1} \sim \chi^2(M)$$

where SSE_1 is the sum of squared errors estimated from the unrestricted equation, SSE_2 is the sum of squared errors estimated from the restricted equation, N is the number of observations, and M is the number of lags.

The results differ by the number of lags because most of the explanation is accomplished with two lags. Therefore, we provide the results of this estimation for the

[20] In the case of the test of Equation (1), for example, the restricted models have $\delta_m = 0$ for all values of m.

FIGURE 2
(A) Results of the Granger Causality Tests for the Contribution of Lagged Net Premiums Written and Lagged Direct Losses Incurred in Explaining Base Year Net Premiums Written (B) Incremental R^2 of Lagged Direct Losses Incurred in Explaining Net Premiums Written

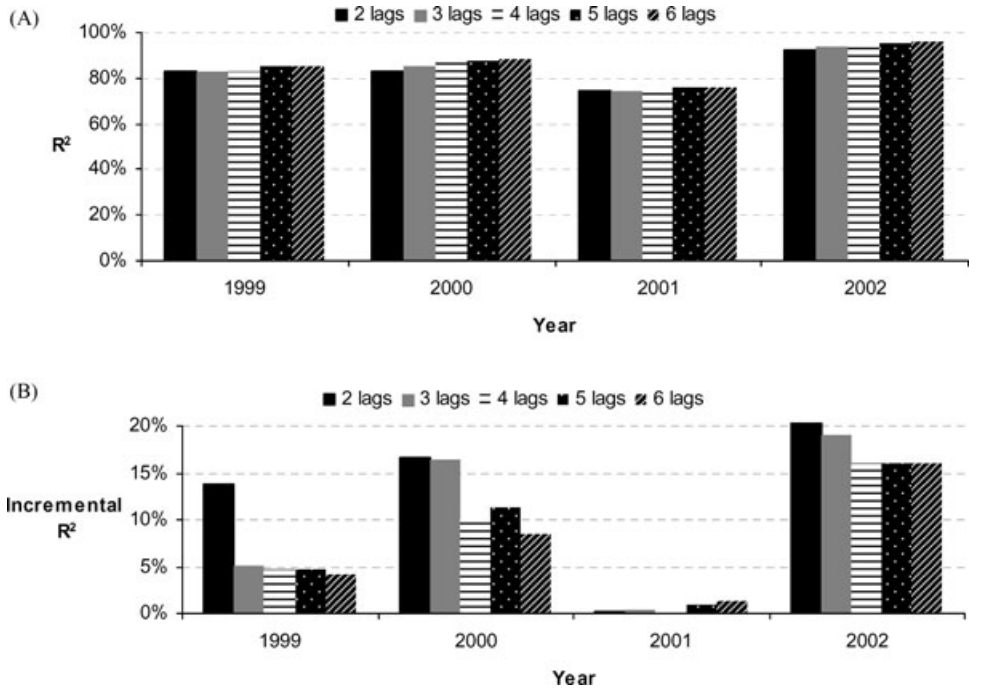


2-year lags in Table 1. We provide illustrations of the effects of the number of lags, in terms of explanatory power, in Figures 2A and 2B for Equation (1) and in Figures 3A and 3B for Equation (2).

The results that we show in Table 1 and Figure 2A support the notion that past losses predict current premiums; that is, premiums increase as loss experience increases. Similarly, except for 2001, past premiums predict current losses, as we show in Table 1; that is, the increase in losses are likely explained by an increased activity of writing policies.[21] Therefore, we conclude that feedback occurs between premiums and losses and that the relation between premiums and losses is not a simple unidirectional one

[21] We would expect a relation such that premiums affect losses in the following period(s) or that losses would affect premiums in the following period(s). The relation that we observe in the 2000 and 2001 periods does not follow this expectation: premiums do not appear to keep up with losses in this period.

FIGURE 3
(A) Results of the Granger Causality Tests for the Contribution of Lagged Net Premiums Written and Lagged Direct Losses Incurred in Explaining Base-Year Net Direct Losses Incurred (B) Incremental R^2 of Lagged Net Premiums Written in Explaining Direct Losses Incurred



but is rather more complex.[22] We do find that the results for 2001 are different from those of the other years because in that year the prior-year premiums are not predictive of losses.[23]

In Figure 2A we see that the year 2001 is different from the other years in explanatory power as well; for premiums in years 1999, 2000, and 2002 prior-year premiums and losses explain close to 90 percent or more of the variation in premiums, whereas in 2001, the explanatory power of 2 years' lagged premiums and losses on base-year premiums written fell to 81 percent. It is interesting that explanatory power is consistent across lag lengths for all base years. In Figure 2B, we show the explanatory power of direct losses in explaining net premiums, over and above that explained by lagged net premiums. The additional contribution to R^2 of direct losses varies each year. For example, direct losses alone contribute up to 12 percent of the variation in net premiums written in 2000 yet explain very little of net premiums in 2001. In

[22] Evidence of feedback between premiums and losses is also found using 3-, 4-, 5-, and 6-year lags.

[23] As indicated by the two-lag R^2, as shown in Table 1, the relation between losses and premiums is not as strong in 2001 as in the other years. In other words, there is less covariance in 2001.

2002, the 2-year lag provides the most explanatory power in contrast to the other base years.

We show the contributions of lagged net premiums and lagged direct losses in explaining current direct losses in Figure 3A. The pattern that we observe is similar to what we saw in Figure 2A: most of the explanation of direct losses is accomplished with two lags of both premiums and direct losses. This relationship is strongest in 2002 when prior-year premiums and losses explain almost 92 percent of the variation in direct losses incurred. In Figure 3B, we show the incremental contribution of net premiums. We see that in base years 1999, 2000, and 2002 direct losses are explained by net premiums written; that is, the losses increase as more premiums are written. However, this relation is not consistent over the 4-year period: premiums written do not explain direct losses in 2001.

We use these figures of relative contributions to illustrate the changing nature of the relation between direct losses incurred and net premiums written. As we show in Table 1, there is a causality relation between direct losses and net premiums written, but this causality is not consistent each year. If we define an unstable, or critical, year as one in which there is a misalignment of direct losses incurred and net premiums written, then 2001 is an unstable, or critical, year.

Annual Changes in Growth Rates. To begin our examination of changes in the behavior of medical malpractice performance variables, we first estimate changes in annual growth rates. In particular, we examine the change in growth rates of net premiums written, direct losses incurred, and direct defense and cost containment fees, as well as total losses incurred. We present the mean and median of the year-to-year change in growth rates in Table 2. As we show in this table, the mean growth rates in direct losses incurred increase significantly in all years, the mean growth rates in defense and claim costs increase significantly in all years except 2000, and the mean growth rates in the total of direct losses and claim costs increase significantly in each year. The mean growth rate in net premiums written increases significantly in 6 of the 9 years.

We must note, however, that the data may be distorted by the entry into and exit out of the medical malpractice insurance market during the sample years. In the year an insurer enters the market, there will be a small amount of net premiums written and little or no direct losses; similarly, in the exit year, there will be little or no premiums written, but there may be large direct losses.[24,25] Considering this phenomena, the

[24] We do find evidence of entry and exit in the market with extremely large outliers occurring for net premiums written, direct losses incurred, and direct defense and claim costs. To control for this, for each variable, we deleted the top 5 percent of companies reporting the highest values and report these results in Table 2. The results for the entire sample are available upon request.

[25] We also examine "total losses and loss expenses incurred," which is the total of all categories of losses and expenses including those expenses such as "adjusting and other unpaid," not included in the other variables. Therefore, companies with positive, nonzero values in any of these categories may be included in this variable regardless of whether they reported zero or negative values in the other categories of loss and expenses. The results of this analysis provide additional support for our findings. Significant, positive growth in the median of

TABLE 2
Cross-Sectional Tests of Annual Growth Rates, 1995–2002

Variables		1994	1995	1996	1997	1998	1999	2000	2001	2002
					Panel A					
Net premiums written *(NPW)*	Mean	0.0153	0.1503*	0.1506*	0.4063*	−0.0150	−0.0312	0.1590*	0.3433*	0.2701*
		(0.5871)	(0.0006)	(0.0002)	(<0.0021)	(0.6394)	(0.5070)	(<0.0001)	(<0.0001)	(0.0001)
	Median	−0.0010	0.0150	0.02442	0.0057	−0.0555*	−0.0158	0.0888*	0.1617*	0.1201*
		(0.9527)	[0.2344]	[0.7691]	[0.5198]	[0.0019]	[0.5070]	[<0.0001]	[<0.0001]	[0.0006]
	N	285	283	290	293	288	233	222	204	174
Direct losses incurred *(DLI)*	Mean	0.2805*	0.3980*	0.2474*	0.2611*	0.4041*	0.6896*	0.2471*	0.6879*	0.2559*
		(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(0.0016)	(<0.0001)	(<0.0001)
	Median	0.1152*	0.0825	0.0633*	0.0919*	0.0063	0.2246*	0.0487	0.3555*	0.1621*
		(0.0461)	[0.1980]	[0.0157]	[0.0065]	[1.0000]	[0.0021]	[0.5999]	[<0.0001]	[<0.0001]
	N	212	218	224	228	217	162	178	175	160
Direct defense and claim costs *(DCCF)*	Mean	0.1452*	0.3137*	0.1585*	0.2598*	0.3557*	0.3284*	0.0906	0.5726*	0.5245*
		(0.0012)	(<0.0001)	(0.0007)	(0.0001)	(<0.0001)	(0.0011)	(0.1128)	(<0.0001)	(0.0002)
	Median	0.0430*	0.1111*	0.0978*	0.0712	0.0266	0.0568*	0.0223	0.1360*	0.1261*
		(0.0304)	[<0.0001]	[0.0447]	[0.1334]	[0.1854]	[0.0220]	[0.6079]	[0.0153]	[0.0060]
	N	190	185	196	203	211	190	189	178	174
Total direct losses incurred *(DLI + DCCF)*	Mean	0.3443*	0.1671*	0.0762*	0.1957*	0.1423*	0.3655*	0.1592*	0.4839*	0.2736*
		(<0.0001)	(0.0008)	(0.0223)	(<0.0001)	(0.0085)	(<0.0001)	(0.0047)	(<0.0001)	(<0.0001)
	Median	0.1619*	0.0844	0.0313	0.1086*	−0.0110	0.2150*	0.0545	0.3411*	0.2121*
		(0.0009)	[0.1147]	[0.0979]	[0.0013]	[0.6998]	[0.0005]	[0.2267]	[<0.0001]	[<0.0001]
	N	168	161	177	180	168	142	154	148	147
					Panel B					
Weighted premium ratio[a]	Mean	0.9717*	0.9930	0.9880	1.0039	0.9978	1.0194	0.9854	0.9352*	0.9326*
	Median	0.9712*	0.9890	0.9968	0.9989	0.9885	0.9825	0.9749	0.9410*	0.8879*
	Weighted	−5.1124	−0.8924	−0.6706	0.5660	−0.2122	1.2011	−1.4478	−5.7130	−3.2840
	t-test	(<0.0001)	(0.3728)	(0.5029)	(0.5718)	(0.8321)	(0.2308)	(0.1489)	(<0.0001)	(0.0012)
	N	312	316	328	318	318	263	253	221	221

Note: The *p*-value for the test of the mean is below the mean in parentheses. The *p*-value for the test of the median using the sign test is in brackets below the median.
[a]The weighted premium ratio is the ratio of net premiums earned to net premiums written, weighted by net premiums earned. For the premium ratio, the number in parentheses is the *p*-value for the weighted *t*-test.
*Indicates the annual growth rate is significantly different from the hypothesized value at the 5% level of significance.

median figure may be more informative because it is less influenced by extreme observations and is more representative of the typical experience of a firm. Therefore, although we observe significant changes in the mean growth rate in net premiums written in 6 out of the 9 years we study, we find that the median growth rate exhibits significant increases for 3 years, 2000, 2001, and 2002, after experiencing a decrease in 1998. We also find that the median growth rate in direct losses incurred increases in all but 3 years, 1995, 1998, and 2000. The greatest increase in direct losses incurred is in 2001. The median growth rate in defense costs and claim containment fees increased in 6 of the 9 years, with the greatest increase again occurring in 2001. What we learn from the analysis of growth rates is that the losses, premiums, defense costs, and claim containment fees do not necessarily grow in a similar manner. This misalignment of premiums and costs suggests possible instability and perhaps deterioration in this market for insurance.

We also examine the ratio of net premiums earned to net premiums written to identify any significant annual changes in market participation. We weight this ratio by net premiums written to avoid the distortion caused by equally weighting all insurers. The rationale behind this test is that in a stable market, net premiums earned should equal net premiums written (H_0: ratio of net premiums earned to net premiums written $= 1$). If this ratio is larger than 1, this implies that individual insurers are writing fewer premiums and reducing their participation in this market; if this ratio is less than 1, insurers are assumed to be writing more premiums and expanding their participation in the medical malpractice insurance line.

We provide the results of this test in Table 2, Panel B. We find significant changes in this ratio in 1994, 2001, and 2002. In 1994, it appears the market for medical malpractice is expanding. This view is supported by the general trend in Figure 1 that shows the number of companies writing positive direct premiums increasing up through 1997. In the years 2001 and 2002, it initially appears that the market for medical malpractice insurance is expanding; however, a closer look reveals a different picture. The number of insurers reporting positive values in Table 2 for both net premiums earned and net premiums written has dropped from a high of 328 insurers in 1996 to a low of 221 in 2001 and 2002. The trend in Figure 1 also supports this conclusion with the number of insurers writing positive direct premiums written falling from a high of 276 in 1997 to a low of 248 in 2001 and 253 in 2002. Putting the information from the ratio of earned to written premiums together with the trend in the number of insurers, we conclude that the insurers that remain in this market are writing more premiums. Unfortunately, with the limited data available it is not possible to determine whether the remaining insurers are writing more policies, charging higher premiums for the same, or fewer, number of policies, or using a combination of both.

Changes Across Time. Annual increases in premiums and losses do not necessarily indicate a problem because some increase in these figures is expected and even

total losses and loss expenses incurred occurs in 2001 and 2002, and significant, positive growth in the mean occurs in 1997, 1998, 2001, and 2002. These results are also available upon request.

desired. We expect a strong, positive relationship between premiums and losses. However, under normal or desired conditions, premiums and losses should increase at approximately the same rate if investment income growth is constant. The problem arises when either premiums or losses grow significantly more than the other over a prolonged period of time while investment income remains constant or decreases. Under these circumstances, premium growth that significantly outpaces the growth of losses may indicate greed on the part of insurers, while more rapid growth in losses relative to premiums may indicate insurer financial instability and an inability to pay future claims. We examine the paths of growth rates over the time period 1993 through 2002 for both premiums and losses to identify whether the paths are similar. As in Lai et al. (2000), we use a 7-year span to calculate two 4-year period geometric growth rates within that time span. For example, with ending year 1999, the 7-year time span encompasses 1993–1999 and the two 4-year growth periods we compare are 1993–1996 and 1996–1999. We calculate the difference in these two growth rates and test whether there is a difference in the growth rates between the two time periods. The difference in growth rates is calculated as follows:

$$DV = \left(\sqrt[3]{\frac{V_t}{V_{t-3}}} - 1 \right) - \left(\sqrt[3]{\frac{V_{t-3}}{V_{t-6}}} - 1 \right) \tag{3}$$

where DV is the difference in the geometric means and V_t is the amount of premiums or losses for year t.[26]

We compare the growth rates of net premiums written, direct losses incurred, direct defense and cost containment fees, net investment income, and policyholder surplus. We include net investment income and surplus to address the argument that has been made by opponents of tort reform that insurers are raising premiums and desire tort reform to make up for reduced investment income and decreased surplus.

We present the results in Table 3. We do not find a significant change between 4-year periods in growth rates in net premiums written. We observe a significant increase in the median growth rate in direct losses incurred for the comparison ending in 2001. Interestingly, we find that the median growth in direct defense and claim costs declines between the two 4-year periods in ending year 2000 but no significant changes otherwise. Importantly, we observe a decrease in the growth of policyholders' surplus with all period comparisons, except for the median value in ending year 1999, as well as a decrease in the growth rate of net investment income for all periods except ending year 2002.

From an insurer's viewpoint, steps must be taken to improve performance whenever increases in premiums cannot keep pace with increases in losses over a period of time. We use two variables to test the impact of claim trends on premiums. First, we calculate the loss ratio as total losses to net premiums written, with total losses as the

[26] We differ from Lai et al. (2000) by using geometric growth rates instead of arithmetic growth rates. Standard practice uses geometric models to make basic predictions of economic variables and use of arithmetic means can lead to bias. In addition, the geometric mean better reflects growth, taking into account compounding.

TABLE 3
Tests of Differences of Growth Rates Between Time Periods

		Panel A			
		Ending Year			
Growth in...		1999	2000	2001	2002
Net premiums written	Mean	−0.0467	0.0116	0.1086	−0.1191
		(0.5277)	(0.9118)	(0.2711)	(0.2406)
	Median	−0.0774	−0.0564	0.0432	0.0577
		[0.0514]	[0.0637]	[0.3751]	[0.0884]
	N	207	197	183	167
Direct losses incurred	Mean	−0.0200	−0.8694	0.1396	−0.2157
		(0.7674)	(0.3048)	(0.0977)	(0.2582)
	Median	−0.0326	−0.1217	0.1269*	−0.0263
		[0.4534]	[0.1192]	[0.0042]	[0.4976]
	N	144	165	134	139
Direct defense and claim costs	Mean	−0.1239	−0.0864	−0.0055	−0.0431
		(0.1167)	(0.3019)	(0.9430)	(0.5342)
	Median	−0.0541	−0.0870*	−0.0425	0.0112
		[0.3041]	[0.0233]	[0.6084]	[1.0000]
	N	161	153	137	141
Net investment income	Mean	−0.0924*	−0.1033*	−0.0497*	−0.0412
		(<0.0001)	(0.0004)	(0.0039)	(0.0799)
	Median	−0.0480*	−0.0497*	−0.0447*	−0.0253
		[<0.0001]	[<0.0001]	[0.0008]	[0.0865]
	N	206	196	180	165
Policyholder surplus	Mean	−0.0371*	−0.1412*	−0.1196*	−0.0629*
		(0.0059)	(<0.0001)	(<0.0001)	(0.0003)
	Median	−0.0153	−0.0884*	−0.0881*	−0.0675*
		[0.0813]	[<0.0001]	[<0.0001]	[<0.0001]
	N	206	195	182	164
Loss ratio	Mean	0.1303*	0.0940*	0.1121*	0.2175*
The ratio of the sum of direct		(0.0270)	(0.0037)	(0.0105)	(0.0025)
losses incurred and direct cost	Median	0.0626*	0.0683*	0.0937*	0.0983*
containment costs to net		[0.0086]	[0.0004]	[0.0005]	[0.0002]
premiums earned	*N*	99	98	92	87
		Panel B			
Weighted premium ratio[a]	Mean	0.2390	0.1992	0.8715*	0.0539
The ratio of net premiums		(0.0916)	(0.1815)	(0.0348)	(0.0816)
earned to net premiums	Median	0.0066	−0.0024	−0.0039	−0.0105
written		[0.4124]	[0.5893]	[0.4741]	[0.0474]
	N	185	173	162	152

Note: The *p*-value for the test of the mean is below the mean in parentheses. The *p*-value for the test of the median using the sign test is in brackets below the median.

[a] The weighted premium ratio is the ratio of net premiums earned to net premiums written, weighted by net premiums earned. For the premium ratio, the number in parentheses is the *p*-value for the weighted *t*-test.

* Indicates the annual growth rate is significantly different from the hypothesized value at the 5% level of significance.

sum of direct losses incurred and direct defense and cost containment fees. If this ratio increases, insurers may decide to reduce the amount of business written in the market or to withdraw from the market entirely. Second, we calculate the 7-year change in this ratio. We calculate a *t*-distributed test of the hypothesis that there is no difference in the growth rates over the two periods, and present these tests in Table 3. Once again, we examine the four 7-year periods ending in 1999, 2000, 2001, and 2002. We find a significant deterioration in both the mean and median growth rates in the loss ratio for all time spans studied. For ending year 2002, we found results that indicate the average loss ratio increased 22 percent more from 1999 to 2002 than from 1996 to 1999. The corresponding median loss ratio increased 10 percent.

These results must, however, be viewed with caution for several reasons. Only positive, nonzero numbers can be used in these calculations so companies that report legitimate negative or zero values are not included. However, it is highly likely that those insurers that report legitimate zero or negative values are some of the worst-performing insurers that are either temporarily suspending their participation in this market or are in the process of withdrawing from it. If this is correct, then our estimates are conservative and actual results are worse than estimated. Second, there is a large decrease in sample size across time that clouds the overall results for analyses that include these years. However, the decrease in sample size itself is very informative. For example, only the strongest companies reporting positive, nonzero values and writing positive premiums are included. If an insurer wrote premiums for several years and then dropped that line, then it is not included in the sample, raising the issue of survivor bias in our sample. The number of companies writing positive net premiums written for all time periods studied fell from 207 in ending year 1999 to 167 in ending year 2002.

Summary of Results of Market Stability. In our examination of annual growth rates, we find a significant increase in the median growth of net premiums written, direct losses incurred, direct defense and claim containment costs, and total direct losses. Our results of tests on the weighted ratio of net premiums earned to net premiums written indicate that individual insurers remaining in the market are writing more net premiums.[27]

Our analysis of insurer performance over time reveals that the growth of policyholder surplus has declined since 1994 while the growth in net investment income steadily deteriorated over time from 1993 through 2001. We also find that the loss ratio of firms has deteriorated throughout the period of this study. Further, the median growth rate of direct losses incurred significantly increased from the period 1998–2001 as compared to 1995–1998 while there was no significant change in the growth rate of net premiums written over this period. As a result, we conclude that the annual increases in the growth rate of net premiums written are a result of increases in the growth rate of direct losses incurred and not as a result of greed on the part of insurers.

More importantly, we observe that the number of insurance carriers with positive direct premiums written in 2001 declines to a 10-year low of 248. We conclude that the medical malpractice market significantly deteriorated from 1998 to 2001 as compared

[27] As stated earlier in the text, with the limited data available it is not possible to determine whether the remaining insurers are writing more policies, charging higher premiums for the same policies, or using a combination of both.

to 1995–1998. A report released by the United States General Accounting Office (GAO) in June 2003 is consistent with these findings. In its report, the GAO reports premium rates for select specialties have greatly increased since 1999. It also finds that from 1998 to 2001, losses have greatly increased while investment income has fallen. From this anecdotal evidence and the preliminary analyses, we observe that losses and claim containment costs have been increasing since at least the mid-1990s. The increase in direct losses incurred continued to accelerate and the loss ratio continued to deteriorate, becoming a chronic problem by 2001. Insurers began leaving the market in 1998 with the lowest number of participants over an 11-year period from 1993 to 2003 occurring in 2001. A comparison of these results with similar measures for other lines of insurance would be a useful extension of this study.

We also use Granger causality analyses to address the issue of whether net premiums are explained by the corresponding direct losses, and vice versa. We confirm that net premiums written are predicted by past direct losses incurred. This analysis also reveals that feedback exists between these two variables in that past net premiums are also predictive of current direct losses incurred for years 1999, 2000, and 2002. However, 2001 losses incurred were not predicted by 1999 and 2000 premiums. Overall, increased losses lead to increased premiums and increased premium amounts lead to higher losses, but this relationship was out of line in 2001.

CAUSES OF THE DECLINE IN THE MEDICAL MALPRACTICE INSURANCE MARKET

In this section, we analyze the possible explanations for a decline in the performance in the medical malpractice insurance market, with the understanding that the decline began in 1998 and ends in 2001. We also perform some analysis using 2002 data.

Examination of Expectations

An insurer must have reasonably accurate information regarding future expectations of the amount of losses incurred, the amount of defense and cost containment fees, net investment income, and other general operating expenses in order to accurately price an insurance policy. In this section, using the same methodology as we did in a previous section, we examine the growth rates of these variables to determine if growth rates changed significantly. We provide the results in Table 3. Briefly, we find no significant changes in the median geometric growth rates of net premiums written and direct defense and claim costs between 1995–1998 and 1998–2001. However, the same cannot be said for direct losses incurred and net investment income. The median geometric growth rate of direct losses incurred is significantly higher from 1998 to 2001 than from 1995 to 1998 while the median geometric growth rate of net investment income decreases significantly during the same period. Assuming that a significant departure from past experience is unexpected by insurers, these results support the view that losses increased more than expected, while at the same time investment income fell below expectations.

Examination of the Management Inefficiency Hypothesis

One of the possible explanations for higher premiums is that insurance companies are not managing their costs efficiently; hence, the policyholders bear the cost of this inefficiency. Management inefficiency also arises in the form of lax underwriting standards and underpricing of policies; however, examination of these factors is

TABLE 4
Tests of Differences of Growth Rates Between Time Periods

		Ending Year			
Growth in...		1999	2000	2001	2002
Commission and brokerage fees	Mean	−0.0733	−0.0414	0.0141	−0.0141
		(0.1209)	(0.4474)	(0.8286)	(0.8419)
	Median	−0.0308	−0.0621*	−0.0027	0.0471
		(0.2015)	(0.0314)	(0.7826)	(0.3866)
	N	138	125	118	108
Dividends paid to policyholders	Mean	−0.0944*	0.0568	−0.2326*	−0.2723
		(0.0127)	(0.3182)	(0.0034)	(0.1530)
	Median	−0.0943*	−0.1547	−0.1401*	−0.1725*
		(0.0020)	(0.2031)	(0.0010)	(0.0079)
	N	102	89	85	42
Total expenses incurred	Mean	−0.0233	−0.0225	−0.0326	−0.0590
		(0.1059)	(0.2335)	(0.3051)	(0.2285)
	Median	−0.0169	−0.0175	−0.0139	0.0026
		(0.0918)	(0.1950)	(0.4071)	(1.000)
	N	203	193	176	163
Total underwriting expenses	Mean	−0.0110	−0.0315	−0.0469	−0.0716
		(0.6014)	(0.1770)	(0.2132)	(0.3119)
	Median	−0.0221	−0.0059	−0.0202	0.0024
		(0.0768)	(0.6117)	(0.4976)	(0.8740)
	N	200	190	176	159

Notes: The number in parentheses under the mean estimate is the *p*-value for the *t*-distributed test of difference from zero. The number in brackets under the median estimate is the *p*-value for the *z*-distributed sign test.

* Indicates that the mean is different from zero at the 5% level of significance.

beyond the scope of this study. Again, using the same methodology developed from Lai et al. (2000), we examine dividends paid to policyholders, total underwriting expenses, and total overall expenses to determine whether higher premiums are explained by management inefficiency. We provide these results in Table 4. The only significant change in growth we observe from 1995–1998 to 1998–2001 is in the case of dividends paid to policyholders. The mean dividends paid to policyholders decreased 23 percent; the median dividend paid to policyholders decreased 14 percent. We do not find that the growth rate in total overall expenses and total underwriting expenses are different in any of the periods studied. There is no evidence to support the hypothesis that insurers are being mismanaged because the growth rates remain stable or decline over all periods studied.

Analysis of Causes for Medical Malpractice Market Deterioration

We use an approach similar to that used by Lai et al. (2000) to explore the factors that explain the deterioration found in the medical malpractice market. Their methodology allows us to test several of the hypotheses examined by previous researchers,

including capacity constraint, change in expectations, fluctuations in interest rates, and rational expectations hypotheses. They examine the causes of the general liability market deterioration in the mid-1980s by regressing the "change in the mean growth rates of net premiums written" as a function of the change in the mean growth rates of losses, variance of losses, expenses, variance of expenses, and five control variables consisting of the premium-to-surplus ratio, total assets of the firm, a reinsurance ceded ratio, a liquidity variable, and a dummy variable indicating organizational form.[28]

As in Lai et al., we use the growth rate in net premiums written as the dependent variable to include both supply and demand dimensions in this analysis. In contrast to Lai et al., we use geometric means instead of arithmetic means.[29] We also replace the organizational form variable, which was found to be insignificant in their analysis, with a group variable (*GRP*) to test the effect of group membership on premiums. Specifically, we expect to find a positive relationship between group membership and premiums, which would confirm that insurers that are part of a group are better able to increase net premiums written as compared to individual, unaffiliated firms. We also differentiate between incurred losses and costs incurred to settle and defend claims. In addition, we examine firm-specific medical malpractice liability data from years 1995 to 2002.

We include two loss variables in our model: direct losses incurred (*GDLI*) and direct defense and claim containment costs (*GDCCF*). We use *GDLI* to capture the effect of changes in the growth rate of incurred losses on premiums while *GDCCF* measures the effect of changes in the growth rate of defense and settlement costs on premiums. We expect to find a positive relationship between net premiums written (*GNPW*) and the two loss variables. We also examine the relationship between the growth in policyholder surplus (*GPHS*) and net premiums written with the understanding that the more capacity an insurer has, the more premiums they may write. We expect to find a positive relationship between surplus and premiums. We also investigate the relationship between reinsurance (*RE*) and premiums with the understanding that the greater the ability of an insurer to cede premiums to a reinsurer, the less premiums they will retain. We expect to find a negative relationship between the amount of reinsurance ceded and the growth rate in net premiums written.

In addition to the group variable, we include three other control variables, including the premium-to-surplus ratio (*PS*), to measure the effect of a firm's leverage on premiums, a size variable (*SIZE*), and a variable measuring liquidity (*LIQ*). We expect to find a negative relationship between *PS* and premiums based on Lai et al.'s (2000) findings that firm's with higher leverage are less able to increase premiums. We also expect to find a positive relationship between *SIZE* and premiums inferring that larger firms may charge higher premiums. Finally, we include the liquidity variable to test

[28] They estimate the net premiums written, losses, variance of losses, expenses, and variance of expenses variables as the difference in growth rates between 1983–1986 and 1980–1983. The five control variables are based on 1986 values.

[29] Standard practice uses geometric models to make basic predictions of economic variables and use of arithmetic means can lead to bias. In addition, the geometric mean better reflects growth, taking into account compounding.

whether firms with higher liquidity tend to charge higher premiums. We expect a positive relationship between liquidity and premiums although Lai et al.'s study did not find a significant relationship.

Another possible explanation for the increase in premiums is decreased net investment income. As a result, we would like to examine the role of net investment income in explaining the growth in premiums. However, as in the previous study, problems of multicollinearity dictate a more parsimonious model. To avoid multicollinearity, we drop net investment income from the model and test the following model:[30]

$$GNPW = \varpi_1 + \varpi_2 GDLI + \varpi_3 GDCCF + \varpi_3 GPHS + \varpi_4 PS + \varpi_5 SIZE + \varpi_6 RE + \varpi_7 LIQ + \varpi_8 GRP \quad (4)$$

where

$GNPW$ = the change in the annual growth of net premiums written between 1995–1998 and 1998–2001,

$GDLI$ = the change in the annual growth of direct losses incurred between 1995–1998 and 1998–2001,

$GDCCF$ = the change in the annual growth of direct defense and claim containment costs between 1995–1998 and 1998–2001,

$GPHS$ = the change in the annual growth of policyholders surplus between 1995–1998 and 1998–2001,

PS = the ratio of premiums written to policyholders' surplus ratio in 2001,

$SIZE$ = the natural logarithm of the firm's total assets in 2001,

RE = the ratio of net reinsurance ceded to direct premiums written in 2001,

LIQ = the ratio of cash plus government bonds to admitted assets in 2001, and

GRP = a dummy variable to capture the organizational form, where 0 denotes that the insurer is part of a group and 1 denotes that it is not part.

$GNPW$, $GDLI$, $GDCCF$, and $GPHS$ are calculated as follows:

$$DV_{2001} = \left(\left(\sqrt[3]{\frac{V_{2001}}{V_{1998}}}\right) - 1\right) - \left(\left(\sqrt[3]{\frac{V_{1998}}{V_{1995}}}\right) - 1\right), \quad (5)$$

where DV is the difference in the geometric means for the performance value, V.

We also estimate Equation (4) with only the change in $GDLI$ to isolate the contribution of losses alone in explaining premiums. We use White's correction for

[30] $SIZE$ is also found to be highly correlated with all the other control variables and LIQ is correlated with RE and the group variable. However, the results remain the same for the other control variables, PS, RE, and GRP, when these variables are removed from the regression.

TABLE 5
Analysis of Net Premiums Written, 1995–2001

Independent Variable Independent Variable	1 Estimated Coefficient (White's Adjusted *t*-Statistics in Parentheses)	2 Estimated Coefficient (White's Adjusted *t*-Statistics in Parentheses)
Intercept	0.5702 (0.8507)	−0.3739 (−0.6479)
Change in annual growth rate of direct losses incurred, 1995–1998 to 1998–2001	0.3692* (4.988)	0.3275* (3.906)
Change in annual growth rate of defense and containment costs, 1995–1998 to 1998–2001	−0.1016 (−0.9969)	−0.0173 (−0.1242)
Change in annual growth rate in policyholders' surplus, 1995–1998 to 1998–2001	0.4812* (2.2964)	0.3953 (1.6985)
Change in the variance of the arithmetic growth rate of direct losses incurred, 1995–1998 to 1998–2001	–	0.000004* (2.999)
Natural logarithm of total assets, 2001	−0.0234 (−0.6814)	0.0269 (0.9117)
Premium to surplus ratio, 2001	0.0098 (0.3945)	0.0554 (1.8706)
The ratio of net reinsurance ceded to direct premiums written, 2001	−0.1798* (−3.2376)	−0.2273* (−4.3779)
The ratio of cash plus government bonds to admitted assets, 2001	−0.8074 (−1.4237)	−1.0621 (−1.8761)
Organizational form dummy variable; 0 if part of a group, 1 otherwise	−0.0238 (−0.2664)	−0.1226 (−1.4064)
F-statistic	10.84* [<0.0001]	15.28* [<0.0001]
R^2	51.11%	65.94%
N	92	81

Note: Dependent variable is the change in the growth of net premiums written from 1995–1998 to 1998–2001.
* Indicates that the coefficient is different from zero at the 5% level of significance.

heteroskedasticity, which provides the correct *t*-statistics regardless of whether heteroskedasticity exists.[31]

We provide the results of the estimation of Equation (4) in Table 5, column 1. From the estimation of this equation, we find a positive coefficient on *GDLI*; as the growth of direct losses incurred increases, the growth in net premiums written increases. We also observe a positive coefficient on *GPHS*, implying that as surplus increases, the

[31] White's corrected *t*-statistics to adjust to heteroskedasticity are provided in all of the regression results that we report.

growth in net premiums written increases.[32] As expected, we find that the reinsurance variable is negatively related to growth in net premiums written. As the amount of premiums ceded to reinsurers decreases, the growth rate of net premiums written increases. Changes in direct defense and claim containment costs, the size of the insurer, the premiums-to-surplus ratio, liquidity, and group membership do not affect premiums.[33] This model explains more than 51 percent of the variation in net premiums written. The results support the expectation that the growth in premium income is positively related to the growth in direct losses incurred; the growth in direct losses incurred alone explains 17 percent of the variation in net premiums written.

We add the change in the variance in the growth of direct losses incurred between 1995–1998 and 1998–2001, *VDLI*, to Equation (4) to test the effect of uncertainty. We provide the results in Table 5, column 2. These results must be viewed with caution, however, because the variances are calculated from a limited amount of observations and may be biased. The model with *VDLI* explains 66 percent of the growth rate in the variation in net premiums written.[34] In addition, we find positive coefficients on both *VDLI* and *GDLI*. In other words, the growth in premium income is positively related to the growth in direct losses incurred and also to increased uncertainty surrounding losses. We also confirm the negative relationship between the growth in net premiums written and both the reinsurance variable and net premiums written.[35] Further, we reestimate this equation with the change in *VDLI* as the only independent variable in order to isolate the contribution of uncertainty in explaining premiums.[36] We find that the variance in the growth of direct losses incurred explains 16 percent of the variation in the growth of net premiums written.

We also estimate the equations using 2002 data and provide these results in Table 6. The results shown in column 1 of this table confirm our observation that direct losses are positively related to net premiums written. Specifically, an increase in the growth rate of direct losses incurred leads to an increase in the growth rate in net premiums written. Interestingly, in contrast to the prior analysis, our proxy for liquidity is significant in this analysis; firms that are less liquid in 2002 experience a higher growth rate in net premiums written. The coefficient of determination, R^2, for the full model is 73 percent. Further, we find that the growth rate in direct losses

[32] Due to multicollinearity, we estimated several different models with and without the correlated variables to check for robustness. The coefficient on *GPHS* was not always significant in these other models, while the coefficients on *GDLI* and *RE* were always significant. As an additional check, we regressed *GPHS* on *GNPW* alone and neither the model itself nor the coefficient on *GNPW* was significant. The R^2 for this model was only 0.4 percent.

[33] Unfortunately, the effects of net investment income on net premiums written cannot be included in this analysis due to high correlation with both direct losses incurred and policyholder surplus. We did regress the growth in net premiums with the growth in net investment income and find no relationship.

[34] The sample size in this model decreases to 81 due to the additional data requirements to calculate this variable. Because this is an arithmetic estimate, positive, nonzero values for direct losses incurred must be available for all years from 1995 to 2001.

[35] However, in this model, the coefficient on the growth in policyholders' surplus, *GPHS*, is no longer significant in this model.

[36] The results are not shown but are available upon request.

TABLE 6
Analysis of Net Premiums Written, 1996–2002

Independent Variable	1 Estimated Coefficient (White's Adjusted *t*-Statistic in Parentheses)	2 Estimated Coefficient (White's Adjusted *t*-Statistic in Parentheses)
Intercept	−0.1772	0.0617
	(−0.3071)	(0.0904)
Change in annual growth rate of direct losses incurred, 1996–1999 to 1999–2002	0.6543*	0.3885*
	(5.5641)	(3.2397)
Change in annual growth rate of defense and cost containment, 1996–1999 to 1999–2002	0.1018	0.2334
	(1.1532)	(1.3590)
Change in annual growth rate in policyholders' surplus, 1996–1999 to 1999–2002	0.1567	0.2675
	(0.9639)	(1.3485)
Change in the variance of the arithmetic growth rate of direct losses incurred, 1996–1999 to 1999–2002	–	0.00001*
		(3.8629)
		(3.8629)
Natural logarithm of total assets, 2002	0.0167	0.0080
	(0.5744)	(0.2284)
Premium to surplus ratio, 2002	0.0432	0.0164
	(1.5088)	(0.4232)
The ratio of reinsurance ceded to direct premiums, 2002	0.0109	−0.0022
	(0.4875)	(−0.0856)
The ratio of cash plus government bonds to admitted assets, 2002	−0.8894*	−0.4951
	(−1.9993)	(−0.6490)
Organizational form dummy variable; 0 if part of a group, 1 otherwise	−0.0881	−0.1399
	(−0.9634)	(−1.6609)
F-statistic	29.68*	40.72*
	[<0.0001]	[<0.0001]
R^2	73.19%	85.33%
N	96	73

Note: The dependent variable is the change in the annual growth rate in net premiums written from the period 1996–1999 to 1999–2002. Table values are parameter estimates, with *t*-distributed statistics below in parentheses. All variances are adjusted using White's correction.

* Indicates that the coefficient(s) different from zero at the 5% level of significance.

incurred alone explains over 25 percent of the variation in the growth rate of net premiums written.

We test the effect of uncertainty during the 1996–1999 and 1999–2002 time periods and provide the results in column 2 of Table 6. As noted previously, these results must be viewed with caution.[37] This model explains 85 percent of the growth rate in the variation in net premiums written. We find positive coefficients on both *GDLI* and

[37] The sample size in this estimation decreases to 73 due to the additional data requirements to calculate *VDLI*.

VDLI. The growth in premium income is positively related to the growth in direct losses incurred and also to increased uncertainty surrounding losses. As before, we estimate this equation with only *VDLI* to isolate the contribution of uncertainty alone in explaining premiums. We find that the variance in the growth of direct losses incurred explains 27 percent of the variation in the growth of net premiums written.

In both time spans, we find increases in direct losses incurred associated with increases in net premiums written. In addition, the variation in the growth in direct losses incurred accounts for approximately 17–25 percent of the variation in growth of net premiums written.

CONCLUSIONS

There is considerable debate among the parties involved in the medical malpractice industry as to whether the medical malpractice insurance market has deteriorated significantly and, if so, the actual causes of this deterioration. We conclude from our analyses that the medical malpractice insurance market experienced significant deterioration between 1993 and 2001. Insurer actions to increase premiums appear justified, based on the faster growing rate of losses than premiums during this period.

Uniquely, in 2001, we find that past losses predict current premiums, yet past premiums do not predict current losses; hence, 2001 premiums appear inadequate. Potential explanations for the effects observed in 2001 include the fact that there were significant increases in the annual growth rates of direct losses incurred and direct defense and claim costs in the 9 years examined. In addition, there is also a significant increase over time in the median growth rate of direct losses incurred between the 1998–2001 period and the 1995–1998 period.[38] We also observe that the number of insurers writing positive direct premiums written fell to 248 in 2001, the lowest number in the years examined in this study. It appears as though insurers have turned the corner in 2001, however, with an infusion of more insurers and a return to a strong relationship in both directions between losses and premiums.

From our analysis, we conclude that the growth in premiums over our period of study is explained by the growth in direct losses and the uncertainty of these losses. The instability in medical malpractice insurance that we observe appears to be driven by the direct losses incurred by the insurance companies.

Our research raises some interesting issues and lines of future research. For example, the relation between premiums and losses suggests that changes in the underwriting and legal systems may affect the growth of losses and, hence, the growth of premiums. Future research might also examine the rate of response for individual insurers. The focus of our present study, as most of the analyses of medical malpractice crises, is on the growth in premiums. An interesting avenue is to examine the rate of response as it may relate to firm-specific characteristics, such as the level of diversification in different insurance lines. Finally, the results of our study confirm previous research

[38] Cross-sectional tests of annual growth rates reveal significant increases in the median value of all variables examined in year 2002 as well but no significant changes over time for direct losses incurred or net investment income as found in ending year 2001. This may explain why predictive ability returns in year 2002.

that a change in expectations resulted in instability in an insurance market. An interesting extension of this study would be to examine the actual losses incurred during these years of deterioration and compare this amount with the corresponding premium amounts. Perhaps that could help address the question of whether there was a change in expectations or the duration of any such effect.

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