“Crises” in Medical Malpractice Insurance: Evidence of Excessive Price-Cutting in the Preceding Soft Market

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Abstract

Treating price as a latent variable, we use firm-level data to analyze whether low ex ante prices during the 1994-1999 soft market in medical malpractice insurance led some firms to grow relatively rapidly and experience adverse loss development, thus putting downward pressure on other firms’ prices and plausibly aggravating subsequent market “crises.” Consistent with the underpricing hypothesis, the results indicate that subsequent loss development was positively related to premium growth among growing firms. Some malpractice insurers that subsequently became insolvent had abnormally large premium growth during the most recent soft market. However, other malpractice writers that ultimately failed shrank significantly during the three to six-year period prior to exit.

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I. Introduction

Markets for many types of property/casualty insurance exhibit soft market periods, where premium rates are stable or falling and coverage is readily available, and subsequent hard market periods, where premium rates and insurers' reported profits significantly increase and less coverage is available. Conventional wisdom among practitioners and many other observers is that soft and hard markets occur in a regular "underwriting cycle," with potentially excessive price-cutting in soft markets amplifying premium rate increases and reduced coverage availability during subsequent hard markets. We use firm-level data during the mid-to-late 1990s soft market in medical malpractice insurance to provide evidence consistent with the hypothesis that some firms under-priced and grew relatively rapidly during that period. The results suggest that market crises during the early 2000s were plausibly aggravated by previous price-cutting.[1]

Dramatic increases in U.S. commercial liability insurance premiums, including medical malpractice premiums, and reductions in coverage availability for some sectors during the mid-1980s received enormous attention and motivated extensive research on those specific problems and on fluctuations in insurance prices and coverage availability more generally. Large catastrophe losses in the United States during the late 1980s and early 1990s spurred further interest in and research on the dynamics of reinsurance and primary insurance market pricing following large, industry-wide losses. Highly publicized crises in many states' medical malpractice insurance markets and, more generally, the hard market for commercial property/casualty insurance that began in 2000 and accelerated following the destruction of the World Trade Center focused renewed attention on the underlying causes of volatility in premium rates and coverage availability, which will very likely continue due to damages and ensuing property insurance rate increases associated with Hurricane Katrina and other storms during 2005.

The median increase in premium rates for medical malpractice insurance sold to internists, general surgeons, and obstetricians / gynecologists in different states increased from 0-2 percent in 1996 and 1997 to 17-18 percent in 2003, ranging up to 60 percent in some states in 2001-2002, after adjusting for inflation (Danzon, Epstein, and Johnson, 2004). In December 2001, the St. Paul Companies, which had been the largest malpractice insurer operating in 45 states, announced its decision to withdraw from the market, citing large losses on its medical liability business. A number of other significant malpractice writers became insolvent, including the Frontier Insurance Group, PHICO, and Reciprocal of America. These events plausibly had some effects on the volume of medical services. Although there is little evidence of widespread, measurable effects of the crisis on the availability of medical services (see U.S. GAO, 2003b; also see Baicker and Chandra, 2004, Dranove and Gron, 2005), physicians in some states went on strike, threatened to leave the state, and/or discontinued certain high risk services.

Like the mid-1980s hard market in medical malpractice insurance and hard markets in commercial general liability insurance in the mid-1980s and the early 2000s, the recent malpractice insurance crises followed a prolonged period of flat or modest premium increases and widespread insurance availability. In response to the earlier crises, many states adopted tort reforms that were intended to reduce the level and unpredictability of claims, including caps on awards for non-economic damages.[2] Some states

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[1] Harrington and Niehaus (2001) provide a survey of theory and evidence on insurance price volatility and insurance cycles. Time-series analyses of insurance underwriting and profit margins often provide evidence of second-order auto-regression, which is consistent with cyclical patterns. Regardless of whether true economic cycles characterize some insurance markets, there is no doubt that fluctuations in insurance premium rates and coverage availability are difficult to explain fully by standard economic models that assume rational agents and few market frictions.

[2] A GAO report (2003a) on the early 2000s crises concluded that, although physicians in most states have experienced some increase in premium rates since 1999, the between-state variation has been significant. It also concluded that the rate of premium increase has been significantly lower in states that enacted tort reforms, specifically, caps on awards for non-economic damages. Danzon, Epstein, and Johnson (2004) provide evidence that states that enacted caps on non-economic damages at or below $500,000 and limits on joint and several liability in response to prior crises had significantly lower premium increases than states without such caps. See Viscusi and

adopted measures to assure the availability of insurance and reduce its cost to physicians, such as the establishment of joint underwriting associations or patient compensation funds. Malpractice insurance markets adopted voluntary changes to reduce insurer risk and establish more robust sources of coverage, including a shift from occurrence to claims-made coverage and the establishment of physician-owned or sponsored mutuals, reciprocals, and risk retention groups to replace many traditional stock companies that withdrew or sharply curtailed their malpractice business during the 1970s and 1980s crises.[3] A number of additional states have adopted caps on malpractice awards in response to recent crises, and others are considering their adoption.

The capacity constraint model of insurance market price dynamics (e.g., Winter, 1988, 1994; Gron, 1989, 1994; also see Gron and Winton, 1991) posits that hard markets are triggered by periodic exogenous shocks to insurer capital, often due to unanticipated growth in claim costs. Given the costs of adding external capital, the contraction of insurer capital in turn leads to a reduction in supply and an increase in the price of insurance.[4] Winter's model implies that anticipation of hard markets and capacity constraints contributes to prior excess capacity and soft market pricing that is symmetric among insurers, but industry folklore about excessive price-cutting during soft markets runs deeper than that. One conjecture is that a tendency towards price inadequacy could arise from heterogeneous insurer expectations concerning future loss costs, or from differences in insurers' incentives for safe and sound operation (McGee, 1986; Harrington, 1988).[5]

Harrington and Danzon (1994) develop and test models of excessive price-cutting during soft markets that could arise from heterogeneity among firms' abilities to forecast claim costs and/or incentives for charging adequate prices. Their empirical strategy is designed to deal with a lack of data on firm-level prices, inherently large noise in traditional price proxies based on firm-level loss ratios (ratios of reported losses to premiums), and the absence of suitable data to measure quantities of coverage sold. They explain that if some insurers undercharge, due to either naive forecasting (e.g., due to inexperience) or excessive risk-taking (due to inadequate incentives for solvency), then when demand is not sufficiently risk-sensitive, those firms will experience relatively rapid premium (revenue) growth, capture market share, and ultimately report poor loss experience.

According to this story, revisions in forecasts of the ultimate cost of claims arising in a given year (known as "loss development") will be indicative of low ex ante prices if price-cutting firms price too low due to naively low forecasts of claim costs with winner's curse effects, as those firms will revise initial cost forecasts upwards as information accumulates about ultimate costs. Similarly, deliberate understatement of initially reported losses by aggressive firms, in order to avoid reporting operating losses arising from low prices, eventually will be accompanied by upward loss development as claims are paid. Harrington and Danzon also hypothesize that other insurers faced with excessive price-cutting will rationally cut prices to some extent to preserve quasi-rents on established business, thus increasing the scope of underpricing during soft markets and further amplifying rate increases during subsequent hard markets.

Born (2005) for related analysis and findings using data from the 1980s and early 1990s. Also see Born and Viscusi (1994).

[3] In theory, physician-owned companies may have informational and/or risk sharing advantages over stock companies in writing a line such as medical malpractice insurance (e.g., Danzon, 1984; Doherty and Dionne, 1993).

[4] Cummins and Danzon (1997; also see Cagle and Harrington, 1995) extend this model to include insolvency risk of insurers and demand for insurance that depends on the firm's financial quality, stressing that a decline in insurer capital leads to a decline in the price of insurance, as measured by the loading charge, but that premium rates may nevertheless increase, to the extent that expected loss costs increase.

[5] McGee (1986) speculated that insurers with optimistic loss forecasts may cause prices to fall below the level implied by industry average forecasts. Winter (1988, 1991a) mentions the possibility of heterogeneous information and winner's curse effects.

The Harrington-Danzon empirical analysis of general liability insurance using firm-level data during the early 1980s soft market provides evidence of excessive price-cutting, suggesting that insurers with relatively high premium growth on average experienced significantly worse loss development than other insurers. Harrington (2004) provides evidence that higher general liability insurance premium growth among firms with growing premiums during the 1990s soft market for general liability insurance was reliably associated with higher loss development.

Danzon, Epstein, and Johnson (2004) analyze medical practice premium rate changes and exits during the mid-to-late 1990s and early 2000s. Using annual *Medical Liability Monitor* data on premium rate changes at the firm-state-specialty level, they find little or no evidence that shocks to insurer capital contributed to increases in premium rates. However, using annual data at the firm-state level, and defining an exit as a reduction in a firm's annual state-level medical malpractice premiums below $100,000, their evidence suggests that capital shocks contributed to malpractice insurer exits. They also provide evidence that malpractice insurance loss development was positively related to premium rate increases at the firm-state-specialty level and with insurer exits at the firm-state level. Estimated exit probabilities were much higher for small firms and for recent entrants, both of which are indicators of inexperience and/or relatively low tangible and intangible capital.[6] Although premium rate changes and exits were not analyzed separately for the 1990s soft market and subsequent hard market, their evidence suggests that excessive price-cutting during the soft market may have contributed to the hard market.

In this paper we provide evidence that firm-level (i.e., aggregate, group-level data for affiliated insurers) growth in malpractice insurance premiums during the 1994-1999 soft market was positively related to subsequent loss development, which is consistent with the hypothesis that some firms priced too low ex ante and grew relatively rapidly during that period.[7] As in Harrington (2004) and related to Harrington-Danzon (1994), we treat firm-level price as an unobservable, latent variable, which, in the presence of cross-firm variation in price-cutting, will produce a positive, contemporaneous relation between firms' loss development and premium growth. The latent variable approach also implies that underlying firm characteristics related to underpricing should have the same signs in reduced form models of loss development and premium growth as a function of those characteristics and other exogenous variables. Our reduced form regressions provide some evidence that non-specialist insurers that sold medical malpractice insurance grew more rapidly with subsequent adverse loss development compared with insurers focusing on malpractice coverage.

We use reduced form equations to estimate abnormal premium growth for a number of significant insurers that subsequently became insolvent, as well as for the St. Paul Companies. Consistent with inadequate ex ante prices, some of the insolvent insurers (but not St. Paul) had abnormally large premium growth during the soft market. However, and consistent with other post-mortems on insurer insolvencies, other insurers that subsequently failed shrank significantly during the three to six-year period prior to exit. If rapid growth induced by underpricing contributed to those firms' financial problems, it must have done so prior to the mid-1990s. The St. Paul Companies experienced slower than average premium growth throughout the sample period.

Section II provides briefly reviews the "perfect markets model" of insurance prices and the implications for medical malpractice insurance prices and premium growth, and it summarizes fluctuations in aggregate medical malpractice insurance premiums, reported claim costs, and pre-tax profits since 1980. We also report the results of time series regressions of the relationship between aggregate premium growth, accident-year loss growth, and changes in the estimated discount factor for loss payments (to reflect investment income). The results indicate a strong positive relation between premium growth and loss and discount factor growth, but they also suggest, albeit somewhat weakly,

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[6] Estimated exit probabilities were much lower for physician-directed firms than for commercial firms, and this differential was greater for small firms.

[7] We conducted similar analysis using data at the level of the individual (subsidiary or stand alone) insurer. The results had similar implications, albeit with lower and less reliably estimated effects.

cyclical variation in premium growth after controlling for loss and discount factor growth. Section III describes the data and methodology of our analysis of loss development and premium growth using firm-level data during the 1994-1999 soft market. Regression estimates of the relation between loss development and premium growth are presented in Section IV. Section V presents the analysis of cross-firm determinants of premium growth and loss development, including estimates of abnormal premium growth for St. Paul and selected insurers that failed during the latter half or subsequent to that period. Section VI concludes.

II. Background

With rational insurers and policyholders, competitive insurance markets, and frictionless capital markets, insurance premiums will equal the risk-adjusted discounted value of expected cash outflows for claims, sales expenses, taxes, and any other costs, including the tax and agency costs of capital. Premium rate levels and rate changes will coincide with levels and changes in discounted expected costs. Because claim payout patterns for claims incurred in a given year, non-claim expenses, and capital costs should be comparatively stable over time, rate changes will primarily reflect changes in expected (forecast) claim and claim settlement costs and changes in interest rates.

In this "perfect markets" framework, long-run rate levels and short-run changes in medical malpractice insurance premium rates will thus reflect levels and changes in:

1. The expected value and timing of claim costs (incurred losses) and claim settlement costs;
2. The interest rates used to discount expected future claim and claim settlement costs;
3. Underwriting expenses (commissions, wages to underwriters, policy issue costs, premium taxes, and so on);
4. Uncertainty about the frequency and severity of claims, including uncertainty about the form and parameters of the relevant probability distributions, which in turn affects the amount of capital that insurers need to hold to achieve low probabilities of insolvency; and
5. The cost of holding capital, including tax and agency costs and any systematic risk that increases owners' required returns.

With competitive supply and frictionless capital markets, intertemporal variation in the margin between premiums and discounted reported claim costs (a construct for the "price" of coverage) will primarily reflect unexpected changes in claim costs. That margin should not be cyclical. Variation in underwriting profits exclusive of investment income should be related to changes in interest rates and should not be cyclical (absent accounting and reporting anomalies). Changes in coverage availability should be caused primarily by adverse selection, which may cause low-risk policyholders to reduce their policy limits or drop coverage.

Broad evidence indicates that the modern expansion of tort liability has produced long-run growth in liability insurance claim costs, episodes of rapid short-run cost growth, relatively large claims settlement costs (e.g., for defense), and substantial uncertainty about the frequency and severity of claims (see below). The long claims tail for general liability and medical malpractice insurance increases the risk of large errors in forecasting claim costs and aggravates asymmetric information. It also makes premiums more sensitive to changes in interest rates. Rapid growth in expected claim costs in conjunction with increased uncertainty about costs and declining interest rates can therefore produce particularly sharp increases in premium rates, and it may be accompanied by increased adverse selection and attendant reductions in policy limits and coverage availability. A key question, however, is whether changes in premium rates and coverage availability are largely explained by these factors, as opposed to other short-run influences that could materially increase insurance market volatility.

Figure 1 plots percent growth in aggregate net (after reinsurance) premiums written for U.S. medical malpractice insurance during 1981-2003. It also shows pre-tax operating margins for medical malpractice insurance on a "calendar-year" basis, which include the effects of changes in loss forecasts for claims arising in prior years. The operating margins equal underwriting profit margins plus the ratio of net investment income (interest and dividends) plus realized capital gains or losses to earned premiums. Dramatic premium growth during the mid 1980s in conjunction with negative operating margins was followed by about a dozen years of relatively stable premiums and favorable margins. Moderate premium growth in 2000 was followed by substantial premium growth in 2002-2003, in conjunction with negative margins.

The possibility of large forecast errors, management of reported losses and thus earnings, and accounting conventions that focus on calendar-year losses, which include revisions in forecasts of costs for claims arising in earlier years, all make it difficult to evaluate the relation between premium growth and loss growth. The unobservability of insurers' claim cost forecasts at the time policies are priced and the possibility of large but rational forecast errors impede sharp conclusions about the explanatory power of the perfect markets model.

Figure 2 plots reported medical malpractice insurance incurred losses (including allocated claim settlement expenses for defense costs and cost containment) on an "accident-year" basis during 1980 (the first year of available accident-year data) through 2003. Two series are shown: (1) losses "initially reported" at the end of the year for events during year t, and (2) losses "developed" through year t+9 or 2003 if sooner, which reflect subsequent revisions to loss estimates for year t. The large premium increases during the mid 1980s were accompanied by sharp increases in initially-reported accident-year losses, as also has been emphasized in post mortems on the general liability insurance crisis (e.g., Harrington, 1988; Harrington and Litan, 1988). Following those increases, initially reported losses grew moderately through 2000 and then jumped in 2001-2003 in conjunction with significant premium increases. Developed losses substantially exceed initially reported losses for 1980-1984. From 1986 through the mid 1990s, however, developed losses are less than initially-reported losses – forecast revisions in accident-year losses have been downward and often large.

As noted, the perfect markets model implies that premiums for long-tailed lines of insurance will be strongly interest rate sensitive. Figure 3 illustrates the length of the claims tails for occurrence and claims-made medical malpractice losses at the industry level arising from injuries in 1994. For occurrence coverage, about one-third of estimated ultimate costs (valued as of 2003) had not been paid by year-end 1999. For claims made coverage, about 15 percent of estimated ultimate costs were unpaid at that time. The shorter claims tail for claims-made coverage reduces forecast error risk, which is a major reason for the growth in that form of coverage over time. Figure 3 also shows that a large proportion of initially reported losses represented estimated costs for claims predicted to have occurred but that had not yet been reported to insurers and for bulk reserves (insurers' forecast of how case reserves in the claim files are likely to develop). IBNR and bulk reserves for occurrence coverage represented over 40 percent of incurred losses in 1996, two years after the end of the 1994 accident year. Both forms of reserves are subject to large forecast errors.

Figure 4 plots estimated discounted factors (the estimated present value of $1 in ultimate claim costs) using estimates of the claims payment tail for occurrences in 1994 (see Figure 3) and spot rates for U.S. Treasury securities.[8] Significant reductions in interest rates during 1983-1987, 1991-1993, and 2001-2003 produced significant increases in the discount factors. Two of those periods coincided with rapid growth in medical malpractice incurred loss estimates, thus putting further upward pressure on medical malpractice premiums. The upward trend in the discount factors since the early 1980s by itself would be expected to contribute to significant overall growth in premiums.

Figure 5 plots three series during 1980-2003: (1) earned premiums less (approximate GAAP) underwriting expenses, including an estimate of non-allocated claim settlement expenses, (2)

[8] We assume a 12-year payout period with payments made mid-year and that remaining unpaid losses as a proportion of incurred losses after 9 years are paid equally over the next three years. Constant maturity U.S. Treasury yields are reported for 1, 2, 3, 5, 7, and 10-year maturities. We used linear interpolation to generate spot rates for years 4, 6, 8, and 9. For Figures 4-6, we use the average spot rates for years t and t-1 to better match the year premiums are earned and losses occur.

discounted initially reported accident-year losses, and (3) discounted developed accident-year losses.[9] Figure 6 plots pre-tax operating profit margins based on discounted reported losses. The figures highlight the question of whether changes in the discounted expected claim costs can plausibly explain most of the changes in premiums. According to the perfect markets model, the large positive margins during 1987-1989 would presumably require (1) a significant increase in risk and the amount of capital needed to support the sale of coverage, (2) a significant increase in the tax, agency, or risk-related costs of capital, and/or (3) unexpectedly low claim cost realizations for those years following the large increase in discounted initial losses and associated premium increases during 1985-1987. Similarly, the negative margins with initial (developed) losses following 1990 (1994) would require a significant decrease in risk, per unit capital costs, and/or unexpectedly large claim costs realizations. More generally, a view that changes in medical malpractice insurance premiums are primarily caused by changes in discounted costs has to confront two challenges: (1) whether changes in expected claim costs are abrupt and large enough to explain abrupt and large premium increases during hard markets, and (2) whether the repeated pattern of soft and hard markets can plausibly be explained by changes in expected claim costs and interest rates.

In order to provide additional evidence of the extent to which changes in claim costs and interest rates can explain changes in aggregate U.S. malpractice premiums, we estimated simple time series models of the relation between premium growth, initially reported accident-year loss growth, estimated discount factor growth, and loss development using annual data during 1981-2003.[10] The models are motivated by the following discrete representation of premiums in year t (P_t):

$$P_t \ = \ \lambda_t \, \delta_t \, E_t(L_t) \qquad (1)$$

where $E_t(L_t)$ is the expectation at the beginning of year t of total losses, L_t, for injuries occurring in year t; δ_t is the discount factor for paid losses arising out of injuries in year t, which depends on the expected payout pattern for injuries occurring in year t and spot interest rates during year t; and λ_t is the loading factor in year t premiums to reflect underwriting expenses and the expected pre-tax profit margin.

Log premium growth from t-1 to t can be written:

$$ln(P_t/P_{t-1}) \ = \ \alpha_0 \ + \ \alpha_1 \, ln(E_t(L_t)/ E_{t-1}(L_{t-1})) \ + \ \alpha_2 \, ln(\delta_t / \delta_{t-1}) \ + \ \varepsilon_t \qquad (2)$$

where $\alpha_0 = 0$, $\alpha_1 = \alpha_2 = 1$, and $\varepsilon_t = ln(\lambda_t / \lambda_{t-1})$. If expected losses and discount factors were observable, estimation of equation (2) with data on log premium growth, log growth in expected losses, and log discount rate growth would provide direct evidence of the extent to which premium growth could be explained by changes in discounted expected claim costs. If the "disturbance," ε_t, were uncorrelated with the regressors, the probability limit of the least squares intercept would be zero, and the probability limits of the least squares slopes would be one. A finding that estimated intercept or slopes were significantly different from those values would imply non-zero correlation between the disturbance and one or both regressors. A perfect markets model interpretation of such a result would require explanation of why non-claim expenses and/or the pre-tax expected profit margins would be correlated with expected loss or discount rate growth.

We estimate equation (2) using 1981-2003 data on log growth in net earned premiums, log growth in initially reported accident-year losses, and log growth in the previously described discount factors estimated with industry level data on paid claims for the 1994 accident year and spot rates on U.S. Treasury securities. In order to produce a closer match between the discount factors and earned premiums and to allow for some adjustment lag to changes in interest rates, we lag the estimated discount factor one year. Log growth in initially reported losses will measure log growth in expected losses with

[9] Discounted losses are calculated using the estimated discount factors shown in Figure 4. The margin between premiums and underwriting expenses should correspond fairly closely to the policies that produced losses each year.

[10] We simply assume stationarity of the series for conceptual reasons (e.g., shocks should be transitory), the small sample size, and related empirical evidence (see Yu and Harrington, 2003).

error, due to updates of loss forecasts between the time policies are sold and the report date, and possibly biased reporting (e.g., for purposes of earnings management). Random error would likely bias the estimated slope for log loss growth downward, and it will reduce the equation's explanatory power. Similarly, measurement error in the estimated discount factors will likewise tend to bias the estimated slope for the discount factor downward and reduce explanatory power.

Table 1 presents the results of estimating several versions of equation (2). The first panel shows ordinary least squares (OLS) estimates using Newey-West standard errors (allowing two lags) to allow for serial correlation in the disturbances. Log loss growth alone explains 64 percent of log premium growth. The estimated slope of 0.82 is significantly less than one at the 0.05 level (standard error equals 0.085).[11] Log loss growth and log growth in the estimated discount factor together explain 76 percent of the variation in log premium growth. The estimated slopes for the two regressors are not significantly different from each other. The third equation in the first panel of Table 1 adds the log of loss development (developed losses through year t+9 or, if earlier, 2003). If insurers systematically inflated (deflated) initially reported losses during hard (soft) markets, log loss development would be negatively related to log premium growth because initial loss forecasts subsequently would be revised downward (upward). Instead, the estimated slope for log loss development is positive (and weakly significant).

The second panel of Table 1 shows maximum likelihood estimates (MLE) of equations that allow for second-order autocorrelation in the disturbances. The MLE estimates could be subject to non-trivial bias in a sample this small. The estimated slopes for log loss growth and log discount factor growth decline compared with OLS but remain positive and statistically significant. The estimate for the first-order autocorrelation parameter implies strong first-order serial correlation in the disturbances. The estimates for the second-order term are negative, as required for "cyclical" disturbances, but they are relatively small compared with their standard errors. By itself, this finding provides only modest support for cyclical variation in log premium growth during 1981-2003, but the sample obviously is very small, and it only includes two soft and two hard markets. Moreover, estimates of an AR(2) model for log loss development (not shown) were consistent with second-order auto-regression in loss forecast revisions.

III. Testing for Underpricing: Data and Methodology

Our latent variable approach to testing for underpricing can be readily motivated under simple assumptions. Omitting firm and time subscripts, let g denote firm j's premium growth, d denote its loss development for claims during the period (i.e., some suitable measure of the difference between loss forecasts for claims in period t as of the end of period t + n versus those initially reported at the end of year t), and p^* denote its unobservable (average) price. Ignoring for simplicity non-random factors that could affect premium growth, assume further that:

$$g = \alpha_0 - \alpha_1 p^* + \varepsilon, \quad \alpha_1 > 0$$

$$d = \beta_0 - \beta_1 p^* + \upsilon, \quad \beta_1 > 0$$

I.e., premium growth and loss development are negatively related to price, where ε and υ are random disturbances.

Substituting for p^* in the loss development equation:

$$d = \gamma_0 + \gamma_1 g + \upsilon - \gamma_1 \varepsilon, \quad \gamma_1 = \beta_1 / \alpha_1 > 0 .$$

Thus, d and g are positively related due to their joint dependence on p^*. Because g is correlated with ε, least squares estimates of γ_1 will be subject to attenuation bias.[12] Thus, the results of estimating the loss

[11] The high correlation between reported losses and premiums for malpractice insurance at the industry level contrasts with analyses using firm-state level data (Danzon, Epstein, and Johnson, 2004) and state-level data on paid claims (Baicker and Chandra, 2004). Firm-level or firm-state level loss data are subject to large random variation in incurred (and thus reported) losses. Given the long claims-tail, changes in paid losses will likely be only roughly correlated with changes in loss forecasts.

[12] Under the standard assumptions that the disturbances are homoskedastic and uncorrelated, the probability limit of the least squares estimator is:

development equation will be biased against finding evidence consistent with price-cutting induced premium growth and adverse loss development.

If x represents a vector of firm characteristics that explain differences in average prices across firms with $p^* = \lambda' x$ plus a disturbance, substituting for p^* in the premium growth and loss development equations will give reduced form equations where the slopes on each characteristic will have the same sign in both equations. The implication is that a characteristic that is significantly related to premium growth and loss development with the same sign is plausibly related to underpricing. An alternative interpretation would require explanation of why the characteristic would be expected to influence premium growth and loss development in the same direction without being related to price. Absent underpricing or biased loss reporting for reasons unrelated to pricing, loss development should be random (unrelated to firm characteristics except by chance).[13]

Given this framework, we use firm-level data (aggregated across insurers with common ownership) for 1994-1999 from the NAIC database to estimate the following model:

$$LRD_{jt} = \delta_0 + \delta_1 \ln(P_{jt} / P_{jt-1}) + \delta_2 \ln(P_{jt-1}) + e_{jt} \qquad (3)$$

where, for firm j and year t, LRD_{jt} is the firm's loss ratio development, defined as the difference between the firm's developed accident-year loss ratio for year t (with losses developed through 2002, to provide at least three years of development for any year) and its initially reported accident-year loss ratio for year t. P_{jt} is log net earned premiums; and e_{jt} is a disturbance term. The variable $\ln(P_{jt} / P_{jt-1})$ is therefore log premium growth during the year.[14]

If relatively high premium growth on average is associated with a relatively low price ($\delta_1 > 0$), loss ratio development could also be positively related to (log) lagged premiums ($\delta_2 > 0$) if larger firms on average have lower premium growth than smaller firms at a given price because of firm life cycle effects. Greater lagged premiums would then imply a lower price for a given level of log premium growth.

The possibility exists that some firms in the sample (see below) could have under-priced and have grown relatively rapidly prior to 1994. If so, it is possible that some may have constrained sales during all or part of 1994-1999 to prevent or slow ensuing financial distress and possible regulatory intervention. In addition, some firms could have constrained their growth during the sample period in response to poor underwriting experience attributable to bad luck rather than ex ante underpricing. In either case, unexpectedly poor underwriting performance could persist temporarily, which could lead to a negative relation between premium growth and loss development for such firms. This possibility suggests that a positive relation between loss development and premium growth due to underpricing by some firms is more likely for a sample of growing rather than shrinking firms.

We estimate equation (3) including year indicator variables with panel data for medical malpractice coverage (occurrence and claims-made combined) during 1994-1999 and two subperiods: 1994-1996 and 1997-1999. The first subperiod was characterized by moderately positive average premium growth and

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$$plim\,(\hat{\gamma}_1) = \frac{\gamma_1}{1 + \frac{1}{\alpha_1^2}\frac{var(\varepsilon)}{var(\upsilon)}}$$

Note that we could just as easily substitute for d in the premium growth equation and regress premium growth on loss development. The fact that $var(\upsilon)$ might be large compared with $var(\varepsilon)$ as a result of potentially large random variation in firm-level claims costs might favor our use of the former approach.

[13] Note also that using loss ratio development should be less vulnerable to omitted variables than the possible alternative of using the developed loss ratio (ratio of developed losses to premiums). The difference between developed and initial loss ratios should largely sweep out systematic cross-firm differences in expected loss ratios at the time coverage is sold that could arise from differences in service intensity, length of the claims tail, or required capital. Moreover, if some firms grow rapidly while exploiting profitable opportunities arising from superior information and risk selection, premium growth would be negatively related to initial and developed loss ratios, but there would be no expected relation between premium growth and loss ratio development.

[14] The use of log growth diminishes positive skewness compared with percentage premium growth.

(thus far) favorable loss development (see Table 2). The soft market deepened during the latter period, prior to the onset of the hard market, with flat average premium growth and (thus far) unfavorable loss development.

To be included in the sample in a given year, a firm had to (1) be included in the NAIC database in that year, the prior year, and 2002 (the year from which Schedule P, Part 2 data on incurred and developed accident-year losses were obtained); (2) have at least $1 million of net earned premiums for medical malpractice insurance in the prior year; (3) have non-negative reported losses for the year; and (4) have positive reported surplus. Given large volatility and skewness in premium growth and loss ratio development, we Winsorized (trimmed) log premium growth at –1 and the 99th percentile value for the sample and loss ratio development at the 1st and 99th percentile values.

The use of 2002 data to calculate loss ratio development ensured at least three years of loss development for the latest sample year, and it plausibly results in more accurate loss development for the earlier years than the alternative of using three-year development for each sample year. Survival bias could operate in two directions, depending on whether exiting firms grew more or less rapidly on average that surviving firms. Under the underpricing hypothesis, the expectation might be that such firms would grow rapidly on average, so that survivor bias would work against finding evidence of underpricing.

Table 2 contains descriptive statistics for log premium growth, initially reported loss ratios, developed loss ratios, and loss ratio development for the overall sample period and the two subperiods. Each variable varies substantially across insurers in each period. Average (median) log premium growth was 5.4 percent (5.3 percent) during 1994-1996 and 0.2 percent (2.8 percent) during 1997-1999. Average (median) loss ratio development was -13 percent (-11 percent) during 1994-1996 and 8.6 percent (-1.8 percent) during 1997-1999.

IV. Does Premium Growth Predict Loss Development?

Table 3 shows least squares estimates of δ_1 and δ_2 for equation (3) and associated p-values using standard errors that are robust to heteroskedasticity and within firm correlation in disturbances. Estimates are shown for each sample period and for subgroups of observations with positive premium growth and non-positive premium growth.[15] The coefficients for log premium growth indicate a strong, positive relation between loss ratio development among firms where such a relation is most likely – firms with positive premium growth – and for the 1997-1999 period, which represents the depth of the soft market ($\hat{\delta}_1 = 1.19$). A 10 percentage point increase in growth for that sample and subperiod implies a 12 percentage point increase in loss ratio development, with p-value < 0.01. For 1994-1996, $\hat{\delta}_1$ for the growing firm subsample is much lower (0.35) but still significant at the 0.05 level for a one-tailed test. For the overall 1994-1999 period and growing firms, $\hat{\delta}_1$ is 0.86 (p-value < 0.01). Thus, the results for growing firms, which abstract from the effects of shrinking firms with poor loss experience, provide strong evidence consistent with price-cutting during the 1994-1999 soft market, especially during 1997-1999, with low-priced firms capturing market share, putting downward pressure on other firms' prices, and ultimately experiencing relatively high loss ratio development.

As would be expected if some firms with poor underwriting experience and associated adverse development shrank in size, there is no reliable relationship between loss ratio development for firms with non-positive premium growth. The estimated relationship is positive for all firms combined for 1997-1999 and the overall period, but not statistically significant. The coefficients on lag logged premiums are close to zero with high p-values.

V. Premium Growth, Loss Ratio Development, and Firm Characteristics

As explained earlier, if a particular insurer characteristic is associated with price, it will likely be either positively or negatively related to both premium growth and loss ratio development. On the other

[15] Selection bias is not a significant issue given that the objective is to estimate parameters for the models conditional on positive or non-positive premium growth.

hand, if a characteristic is related to one variable but not the other, or is related to both variables with opposite sign, the results would suggest that the characteristic is unrelated to price.

Table 4 reports the results of regressing log premium growth and loss ratio development on several variables that could be related to underpricing. Results are reported for growing firms for 1994-1999 and 1997-1999. Estimates for all firms combined and for 1994-1996 generally had the same signs with somewhat higher p-values. The equations include seven firm-level covariates (plus year indicators), each lagged one year: (1) the log of total (all-lines) earned premiums, (2) the proportion of total premiums earned represented by medical malpractice, (3) the log of the number of states where the insurer wrote malpractice coverage, (4) the log of assets, (5) reinsurance recoverable as a proportion of assets, (6) an indicator variable for mutual organizations, and (7) an indicator variable for risk retention groups.

The log of total premiums in the prior year is one measure of general experience, which could be related to the ability to avoid underpricing with winner's curse effects. It also could affect premium growth through life cycle effects. The proportion of total premiums in medical malpractice measures a firm's relative focus on medical malpractice insurance. If specialization in medical malpractice insurance contributes to expertise in pricing and underwriting, and thus the ability to avoid underpricing, this variable should be negatively related to premium growth and loss ratio development. Moreover, most insurers with high proportions of total premiums in medical malpractice are organized or directed by physicians or hospitals, which could measure knowledge and expertise that could help a firm avoid underpricing and associated adverse selection.[16] Similarly, the log of the number of states where a firm writes malpractice coverage is an inverse measure of geographic focus, which thus might be positively related to premium growth and loss development under the underpricing hypothesis.

The log of assets and ratio of reinsurance recoverable to assets are rough measures of incentives for excessive risk taking. Holding the log of total premiums fixed, greater log assets should be associated with larger amounts of capital at risk, as well as intangible capital, thus increasing incentives for adequate pricing.[17] If reinsurance is used to support rapid growth induced by underpricing, the ratio of reinsurance recoverable to assets should be positively related to premium growth and loss development. Harrington and Danzon (1994) provide some evidence that mutuals were less prone to rapid growth and adverse loss development in their analysis of general liability insurance pricing during the early 1980s. Risk retention groups may sometimes be subject to less regulatory oversight than other insurers, which might make that organization form on average more prone to underpricing.

The results of estimating the reduced form equations, shown in Table 4 for growing firms during 1994-1999 and 1997-1999, provide no evidence of underpricing related to overall experience as measured by log total premiums. However, there is modest evidence of underpricing inversely related to specialization in medical malpractice. The proportion of premiums in medical malpractice is negatively and significantly related to log premium growth with two-tailed p-values less than 0.03. This variable is also negatively related to loss ratio development with two-tailed p-values just outside the 0.10 threshold. Hence, the results provide some evidence that medical malpractice insurance specialists were on average less likely to grow relatively rapidly and experience adverse loss ratio development than were non-specialists.

The only other significant firm characteristic in either the log premium growth equation or the loss ratio development equation is log of assets in the premium growth equation for 1994-1999. The

[16] When we estimated the model including an indicator variable for entities that appeared to be organized or directed by physicians or hospitals, the coefficients for this variable generally were not significant, especially in the premium growth equation, and its inclusion had little effect on the other estimates, plausibly because most firms with high proportions of total premiums in medical malpractice insurance fell into this category, for which the mean proportion of premiums in medical malpractice during 1994-1999 was 0.93 (212 observations) versus 0.45 (233 observations) for non-physician or hospital directed firms.

[17] We also estimated models including the ratio of capital to assets, with similar (insignificant) results.

coefficients on the year indicators generally indicate sharply deteriorating loss ratio development over time.

In order to examine whether rapid premium growth was plausibly associated with underpricing for some firms that later failed, we identified all firms with at least $1 million in malpractice premiums during any year during 1993-1996 that disappeared from the NAIC data after 1996. Based on internet searches for explanations of their exit (merger, insolvency, or unknown), we identified 10 entities that became insolvent. Because we obtained accident-year loss data from 2002 annual statements only, we do not have such data for these insurers. However, prior evidence of adverse loss development for failed property/casualty firms (e.g., A.M. Best, 1991) suggests that most of these firms were likely to have experienced adverse loss development prior to their demise.

We analyze the failed firms' premium growth by expanding our sample to include firms for which we have growth and other financial statement data but not accident-year loss data. We also examine premium growth for three other insurers of interest.[18] Two of the entities, the Frontier group and Reciprocal of America, became insolvent after 2002. The third entity, the St. Paul Companies, announced in December 2001 its intended exit from medical malpractice nationwide.[19]

We estimate abnormal premium growth for these 13 entities for 1994-1996, 1997-1999, and 1994-1999 by adding entity level indicator variables to the model reported in Table 4 and estimating the models for growing and non-growing firms combined. The coefficients on the entity indicators are shown in Table 5. Consistent with greater premium growth that is plausibly associated with underpricing, the coefficients for three of the 10 entities that later failed (Coastal Enterprises, PHICO, and Unisource) are positive and statistically significant for the overall period and for either the 1994-1996 subperiod (Unisource) or the 1997-1999 subperiod (Coastal and PHICO). The coefficients for Fremont General are positive but not reliably estimated. On the other hand, the coefficients for five of the 10 entities are negative and significant for 1994-1999, and their slower growth generally began during the 1994-1996 period. To the extent that those entities' ultimate demise was influenced by underpricing and rapid growth, it must have occurred prior to 1994.

The coefficients for Frontier and Reciprocal of America, which failed after 2002, provide no evidence of significantly faster growth except for Frontier during 1994-1996, which was followed during 1997-1999 by significantly slower growth. Reciprocal of America had significantly slower than average growth during 1994-1996. St. Paul had significantly slower growth during the overall period and both subperiods.

VI. Conclusions

We provide evidence that firm-level growth in malpractice insurance premiums for growing firms during the 1994-1999 soft market was positively related to subsequent loss development. This result is consistent with the hypothesis that some firms priced too low ex ante, leading to relatively rapid growth and adverse loss development, and plausibly deepening the soft market, which in turn would be expected to aggravate the subsequent hard market that commenced in 2000. Perhaps due to the inherent difficulty of identifying firm characteristics associated with underpricing using financial statement data, our reduced form estimates of cross-firm determinants of premium growth and loss development during 1994-1999 provide some evidence that lack of specialization in medical malpractice insurance contributed to relatively rapid growth and adverse loss development, but the results are otherwise uninformative.

Consistent with inadequate ex ante prices, some malpractice insurers that became insolvent towards the end of or following the 1994-1999 soft market had abnormally large premium growth. However, other malpractice writers that ultimately failed shrank significantly during the sample period. If rapid growth induced by underpricing contributed to those firm's problems, it apparently did so prior to the mid-1990s. Further research is needed to analyze empirically the extent to which underpricing during this

[18] Each firm experienced adverse loss development through 2002.

[19] St. Paul's affiliates generally are rated A+ by A.M. Best.

and other soft markets amplified premium rate increases and availability problems in subsequent hard markets.

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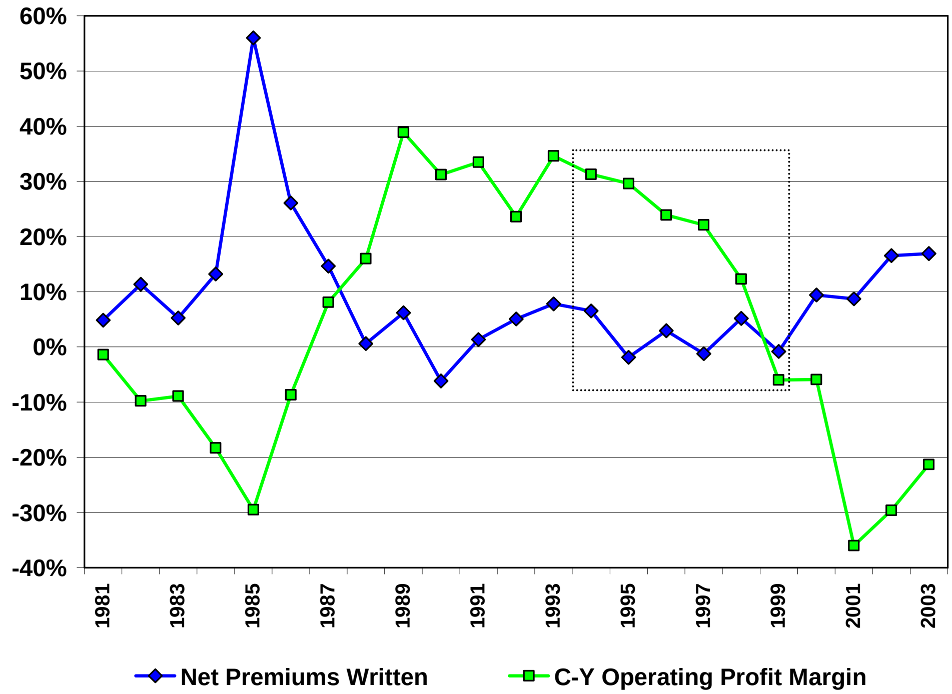
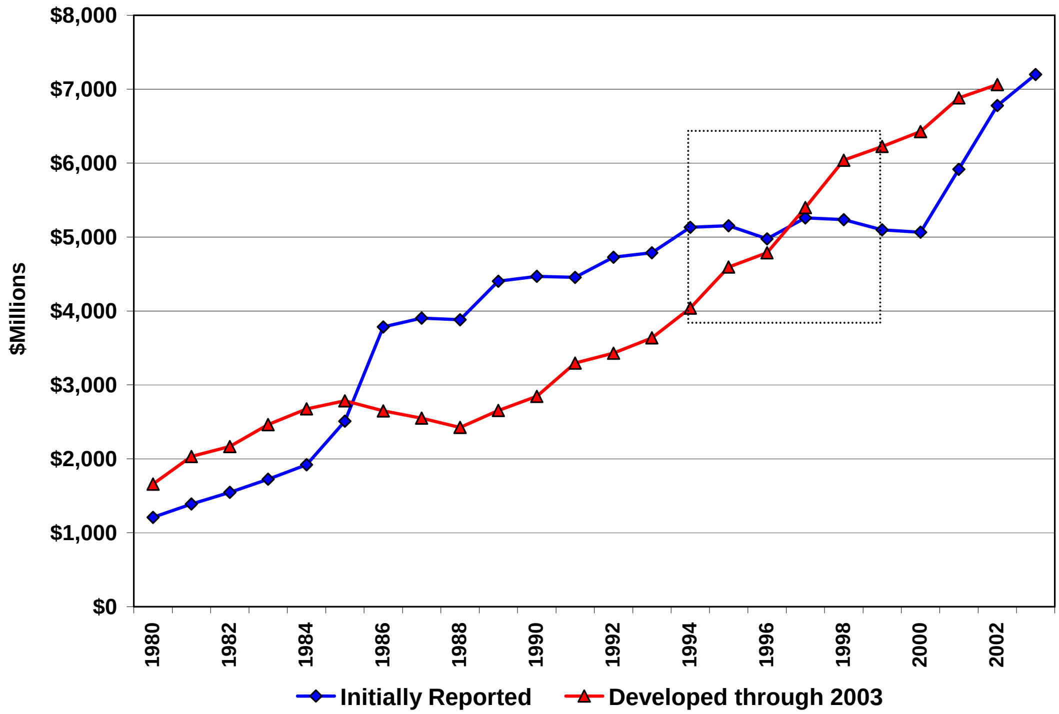
Figure 1
Medical Malpractice Insurance Net Written Premium Growth and Calendar-Year Pre-Tax Operating Profit Margins, 1981-2003
(1994-1999 soft market period highlighted in rectangle)



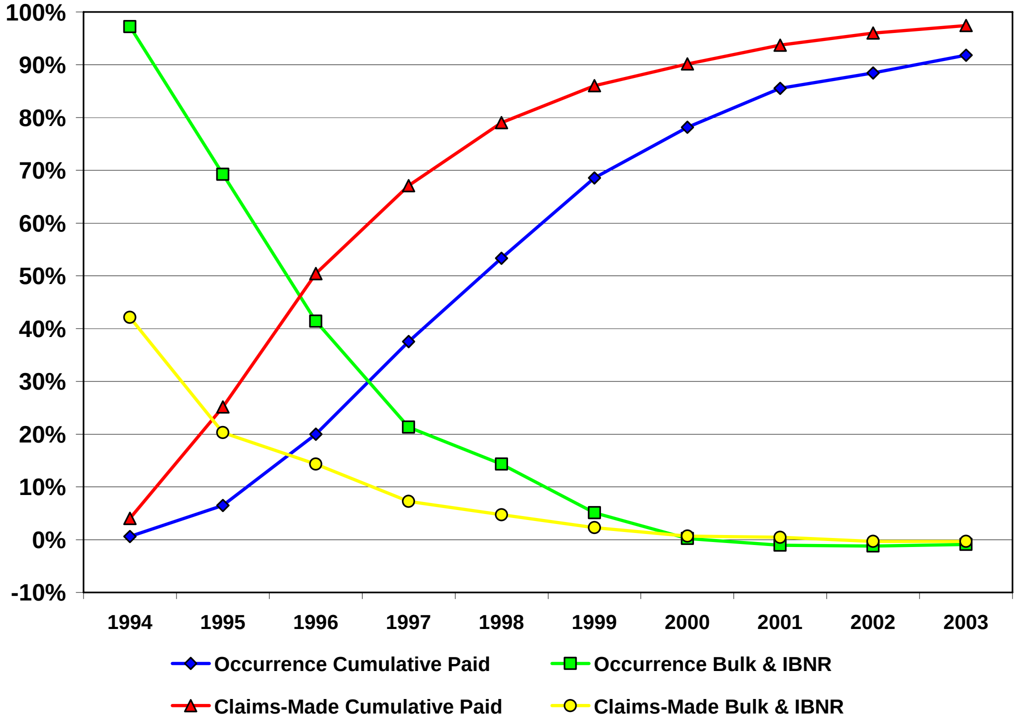
Source: Best's Aggregates & Averages, various editions.

Figure 2
Medical Malpractice Insurance Accident-Year Incurred Losses:
Initially Reported and Developed through 2003



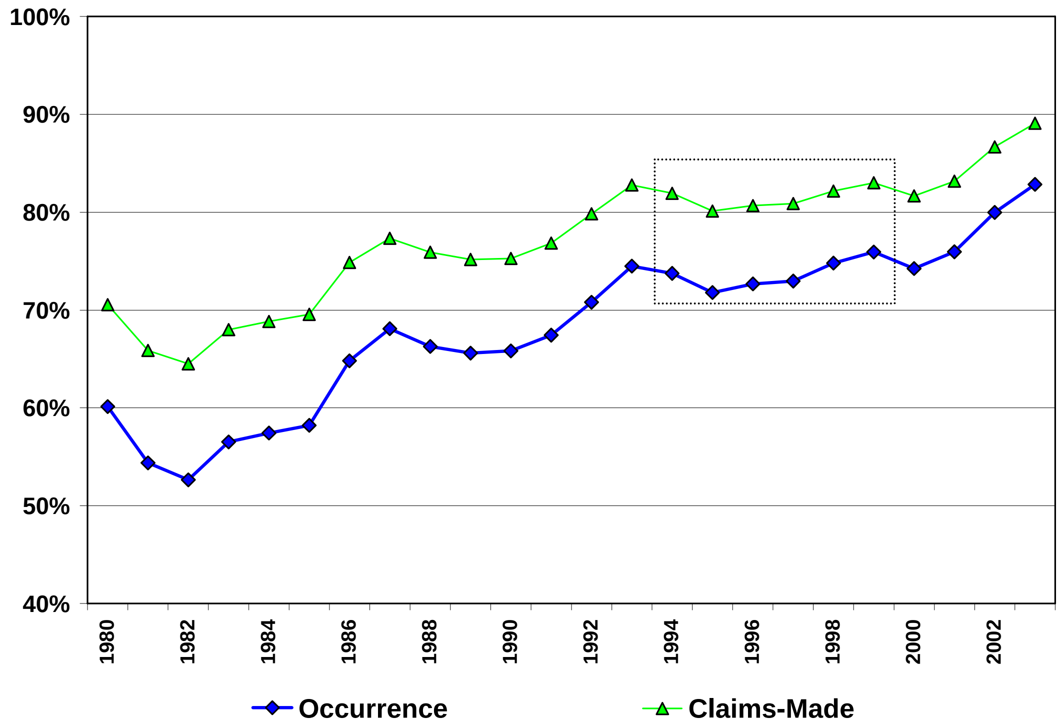
Source: Best's Aggregates & Averages, various editions.

Figure 3
Medical Malpractice Insurance Cumulative Paid Claims and Bulk & IBNR Reserves as Proportions of Estimated Ultimate Incurred Losses for 1994 Accident Year:
Occurrence and Claims-Made Coverage



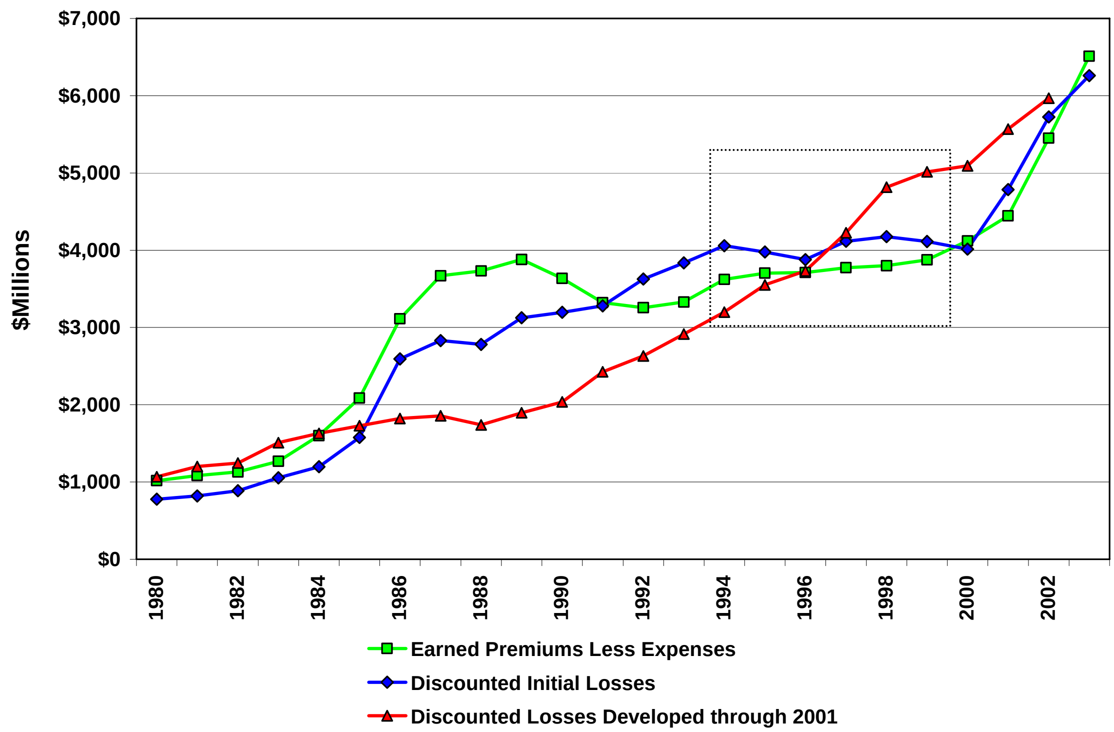
Source: Best's Aggregates & Averages, 2004 edition.

Figure 4
Medical Malpractice Insurance Estimated Discount Factors for
Occurrence and Claims-Made Coverage, 1980-2003



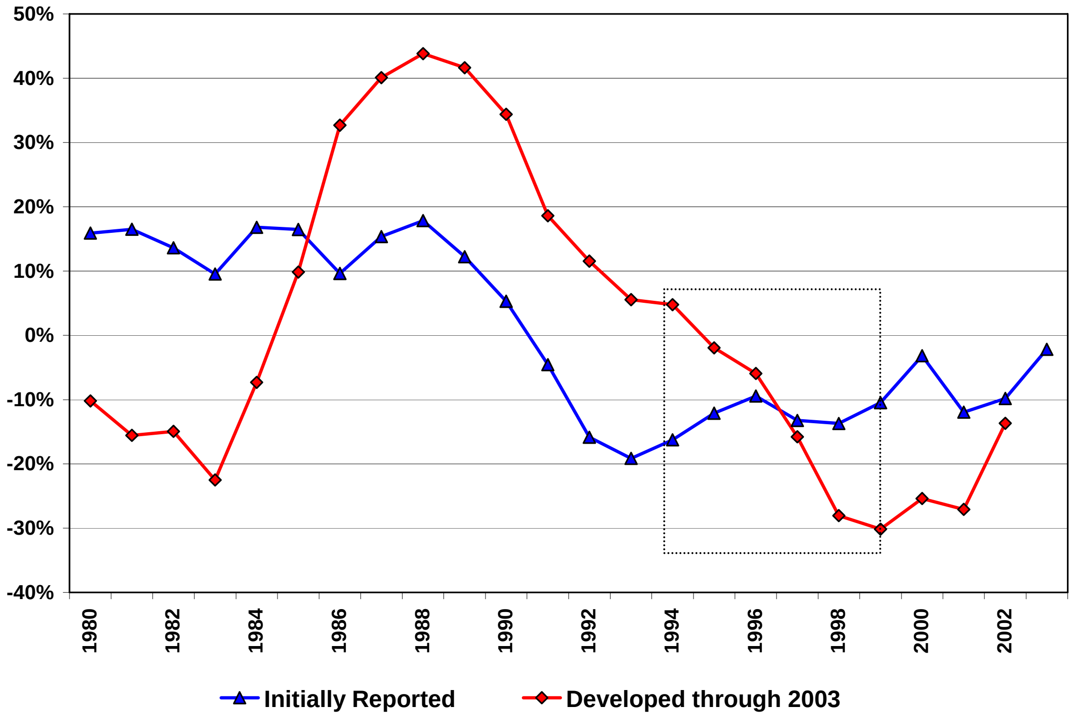
Source: Best's Aggregates & Averages, various editions, and Federal Reserve. Authors' calculations.

Figure 5
Medical Malpractice Insurance Premium Margins and Estimated Discounted Accident-Year Incurred Losses, 1980-2003



Source: Best's Aggregates & Averages, various editions, and Federal Reserve. Authors' calculations.

Figure 6
Medical Malpractice Insurance Estimated Discounted Operating Margins:
Initially Reported and Developed (through 2003) Accident-Year Incurred Losses,
1980-2003



Source: Best's Aggregates & Averages, various editions, and Federal Reserve.
Authors' calculations.

Table 1
Time Series Regressions of U.S. Medical Malpractice Insurance Log Growth in Net Premiums Earned, 1981-2003

Estimation Method	Constant	Log loss $growth_t$	Log discount factor $growth_{t-1}$	Log loss $development_t$	AR(1)	AR(2)	Adj. R^2	Log-Likelihood
OLS	0.019 (0.315)	**0.820** **(0.000)**					0.636	
	0.013 (0.489)	**0.802** **(0.000)**	**0.733** **(0.000)**				0.757	
	0.017 (0.226)	**0.784** **(0.000)**	**0.856** **(0.000)**	**0.080** **(0.054)**			0.803	
MLE	**0.084** **(0.096)**				**0.847** **(0.000)**	-0.236 (0.341)		27.70
	0.044 (0.207)	**0.516** **(0.001)**			**0.739** **(0.002)**	-0.182 (0.387)		41.15
	0.044 (0.217)	**0.478** **(0.000)**	**0.577** **(0.003)**		**0.906** **(0.001)**	-0.224 (0.490)		41.52

Note: p-values in parentheses OLS p-values based on Newey-West standard errors (allowing two lags). Bold values are significant at the 0.10 (0.05) level for a two-tailed (one-tailed) test.

Table 2
Descriptive Statistics for Medical Malpractice Insurer Log Premium Growth, Accident-Year Loss Ratios, and Loss Ratio Development, 1994-1999

				Percentile				
		Mean	Std Dev	5th	25th	50th	75th	95th
1994-1999 N = 445	Log premium growth	0.028	0.275	-0.401	-0.059	0.040	0.126	0.402
	Initial loss ratio	1.015	0.395	0.498	0.761	0.996	1.204	1.684
	Developed loss ratio	1.004	0.551	0.329	0.693	0.945	1.189	1.949
	Loss ratio development	-0.018	0.471	-0.584	-0.243	-0.080	0.080	0.834
1994-1996 N = 219	Log premium growth	0.054	0.237	-0.264	-0.044	0.053	0.158	0.423
	Initial loss ratio	1.041	0.402	0.517	0.787	1.020	1.239	1.878
	Developed loss ratio	0.918	0.428	0.246	0.653	0.904	1.125	1.629
	Loss ratio development	-0.125	0.368	-0.723	-0.308	-0.113	0.013	0.456
1997-1999 N = 226	Log premium growth	0.002	0.307	-0.531	-0.079	0.028	0.113	0.357
	Initial loss ratio	0.989	0.388	0.420	0.719	0.984	1.181	1.640
	Developed loss ratio	1.086	0.639	0.329	0.729	0.986	1.284	2.555
	Loss ratio development	0.086	0.533	-0.494	-0.168	-0.018	0.164	1.115

Note: Log premium growth is $\ln(P_{jt} / P_{jt-1})$, where P_{jt} is log net earned premiums. The initial loss ratio is the accident-year loss ratio reported at the end of year t for occurrences in year t. The developed loss ratio is the accident year loss ratio reported for occurrences in year t at the end of year t+6, or 2002 if earlier. Loss ratios development is the developed loss ratio minus the initial loss ratio. N is the sample size (in firm-years). Statistics are for Winsorized values of the variables (see text).

Table 3
Least Squares Estimates of Relation between Accident-Year Loss Ratios and Premium Growth, 1994-1999

Regressor or Statistic	Sample								
	Log premium growth > 0			All Firms			Log premium growth ≤ 0		
	1994-99	1994-96	1997-99	1994-99	1994-96	1997-99	1994-99	1994-96	1997-99
Log premium growth$_t$	**0.862**	**0.345**	**1.191**	0.149	-0.083	0.286	-0.163	-0.343	-0.095
	(0.005)	**(0.090)**	**(0.009)**	(0.291)	(0.546)	(0.205)	(0.447)	(0.331)	(0.711)
Log premiums$_{t-1}$	-0.007	-0.016	-0.001	-0.024	-0.027	-0.024	-0.001	-0.020	0.012
	(0.781)	(0.525)	(0.982)	(0.371)	(0.286)	(0.464)	(0.985)	(0.616)	(0.727)
Adj. R^2	0.240	0.080	0.264	0.092	0.029	0.066	0.088	0.035	0.090

Note: The regression equation is: $LRD_{jt} = \beta_0 + \beta \, ln(P_{jt} / P_{jt-1}) + \beta_1 \, ln(P_{jt-1}) + \upsilon_{jt}$ where, for firm j and year t, LRD_{jt} is the loss ratio development (developed loss ratio – initial loss ratio) P_{jt} is net earned premiums, and T is a vector of year indicator variables. Winsorized values of the variables are used (see text). Two-tailed p-values based on robust cluster standard errors in parentheses beneath coefficient estimate. Bold values are significant at 0.10 level (0.05) level for a two-tailed (one-tailed) test.

Table 4
Log Premium Growth and Loss Ratio Development Regressions,
Firms with Log Premium Growth > 0

	1994-1999				1997-1999			
	Log Premium Growth		Loss Ratio Development		Log Premium Growth		Loss Ratio Development	
Variable	*Coeff.*	*p-value*	*Coeff.*	*p-value*	*Coeff.*	*p-value*	*Coeff.*	*p-value*
Log total premiums	-0.076	0.123	0.018	0.880	-0.074	0.267	0.011	0.951
Proportion prem. med. mal.	**-0.141**	**0.027**	*-0.306*	*0.105*	**-0.204**	**0.026**	*-0.476*	*0.104*
Log number of states	0.003	0.860	0.012	0.785	-0.009	0.707	-0.008	0.901
Mutual	-0.053	0.125	0.053	0.672	-0.010	0.842	0.108	0.513
Risk retention group	0.009	0.794	0.023	0.802	0.041	0.420	0.021	0.873
Log assets	**0.069**	**0.077**	0.001	0.995	0.070	0.181	0.029	0.841
Reins. recoverable / assets	-0.114	0.243	0.051	0.863	-0.133	0.280	0.102	0.777
1995	**-0.051**	**0.063**	0.067	0.111				
1996	-0.032	0.315	**0.131**	**0.025**				
1997	**-0.092**	**0.001**	**0.144**	**0.019**				
1998	0.011	0.821	**0.419**	**0.000**	**0.100**	**0.013**	**0.250**	**0.002**
1999	-0.033	0.363	**0.290**	**0.000**	**0.053**	**0.076**	**0.110**	**0.106**
Constant	0.311	0.178	-0.365	0.596	0.205	0.495	-0.483	0.615
R-squared	0.128		0.233		0.149		0.282	

Note: Bold values are significant at the 0.10 (0.05) level for a two-tailed (one-tailed) test based on robust standard errors.

Table 5

Estimated Abnormal Log Premium Growth during 1994-1999 for Selected Entities

		1994-1999		1994-1996		1997-1999	
Category	Entity	*Coeff.*	*p-value*	*Coeff.*	*p-value*	*Coeff.*	*p-value*
Insolvent, ceased reporting prior to 2002	Associated Physicians	**-0.723**	**0.000**	**-0.485**	**0.000**	**-0.714**	**0.000**
	Coastal Enterprises	**0.129**	**0.000**	0.035	0.309	**0.196**	**0.000**
	Fremont General	0.074	0.129	0.092	0.123	0.085	0.184
	Legion	**-0.265**	**0.000**	**-0.313**	**0.000**	**-0.257**	**0.001**
	Med. Mal. Ins. Assn.	**-0.128**	**0.026**			**-0.211**	**0.006**
	Paradigm	**-0.150**	**0.000**	**-0.285**	**0.000**	0.029	0.640
	PHICO	**0.054**	**0.074**	**-0.111**	**0.002**	**0.190**	**0.000**
	PIE Mutual	**-0.347**	**0.000**	**-0.243**	**0.000**		
	Reliance	-0.030	0.404	-0.043	0.402	-0.033	0.514
	Unisource	**0.230**	**0.000**	**0.362**	**0.000**	0.061	0.379
Insolvent, reported through 2002	Frontier	-0.006	0.825	**0.103**	**0.002**	**-0.126**	**0.003**
	Reciprocal of America	-0.044	0.128	**-0.087**	**0.018**	-0.017	0.737
Exited med. mal.	St. Paul	**-0.119**	**0.001**	**-0.128**	**0.018**	**-0.124**	**0.014**

Note: Bold values are significant at the 0.10 (0.05) level for a two-tailed (one-tailed) test based on robust standard errors