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Price Cutting in Liability Insurance Markets

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Abstract

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Disciplines

Education Economics | Insurance | Other Education | Real Estate

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Price Cutting in Liability Insurance Markets*

I. Introduction

The commercial general liability (GL) insurance market (which includes product liability insurance) experienced sharp increases in premium rates, limited availability of coverage, and modifications in coverage terms during the mid-1980s. This "crisis" or "hard market" was preceded by a "soft market" with declining premium rates and deteriorating insurer financial results in the early 1980s. The hard market coincided with large upward revisions in reported claim liabilities for GL policies sold in prior years. Considerable debate has addressed whether this volatility in insurance prices and availability can be fully explained by changes in discounted expected costs of providing coverage, and, if not, possible causes of variation.

Many industry analysts believe that the early 1980s soft market for GL insurance represented a particularly severe episode of price cutting to preserve market share. According to this view, price cutting resulted in premium rates that were

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inadequate given information available at the time policies were sold. Attendant operating losses contributed to the subsequent hard market.[1] The largest property-liability insurer insolvencies in the mid-1980s are asserted to have been caused by deliberate or irresponsible underpricing of GL insurance during the early 1980s. These insurers also are alleged to have deliberately underreported claim liabilities and used reinsurance to hide underpricing and capital inadequacy prior to failure (U.S. House of Representatives 1990).[2]

Prior research has focused on causes of the mid-1980s price increases. Possible explanations include the effects on discounted expected costs of declining interest rates and increases in the expected value and variance of claim cost distributions (Clarke et al. 1988; Harrington 1988). Several studies consider whether unexpected increases in claim liabilities for prior years' policies, in conjunction with capital adjustment costs, led to large backward shifts in short-run supply (Winter 1988, 1991a; Gron 1989, 1992; Cummins and Danzon 1991). Price behavior prior to the mid-1980s increases, or in other soft market periods that have preceded abrupt price increases, has received little attention. Apart from possible fluctuations due to capital adjustment costs (Winter 1988, 1991a; Gron 1989, 1992), there has been no analysis of whether competition could cause prices in soft markets to fall below levels needed ex ante to cover expected costs and ensure solvency.[3]•

This article provides a theoretical and empirical analysis of alleged underpricing of GL insurance during the early 1980s. We explore theoretically whether competition among heterogeneous insurers can cause prices to fall temporarily below costs. In our analysis, some firms may price below cost because of moral hazard that results from limited liability, risk-insensitive guaranty programs, and uninformed or unconcerned consumers. Firms also may price below cost due to heterogeneous information concerning future claim costs that results in low loss forecasts relative to full-information conditional expectations. Loss forecasting errors and consequent winner's curse effects may have been especially likely during the early 1980s because of large changes

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1. Industry analysts also commonly believe that prices in GL and other property-liability lines are cyclical with periods of rate inadequacy followed by substantial premium increases and availability problems (e.g., Stewart 1984). Several studies provide evidence that insurer operating results exhibit second-order autocorrelation that is consistent with a cycle (e.g., Cummins and Outreville 1987; Smith 1989).

2. The 1980s experience contributed to substantial changes in state solvency regulation, including the development of risk-based capital requirements, and it increased pressure for federal regulation.

3. Using aggregate time-series data for property-liability insurance, Gron (1992) finds little support for any influence of changes in capital on price changes during soft markets. Winter's (1991a) empirical results using aggregate time-series data are inconsistent with the predictions of capital shock models during the early (and mid-) 1980s. Winter (1991b) provides an overview of capital shock explanations of fluctuations in price and availability.

in the distribution of losses.[4] In response to underpricing by some firms, our analysis suggests that other firms may cut prices to preserve market share and thus avoid loss of quasi rents from investments in tangible and intangible capital. Thus, a subset of firms can cause prices for other firms to fall below costs in the short run.[5]

Our empirical analysis employs cross-sectional data from the early 1980s to test whether moral hazard and/or heterogeneous information contributed to differences in prices and growth rates among firms. Thus, we assume that other firms' price responses to low prices due to moral hazard or heterogeneous information do not eliminate price variation. Price cutting by other firms would reduce price variation and thus reduce the power of our tests. Since the ideal data on price and quantity of business for homogeneous policies are not available, we analyze two related variables: (1) loss forecast revisions and (2) premium growth rates. A number of studies have analyzed multiline loss forecast revisions ("loss reserve errors") for property-liability insurers (Weiss 1985; Grace 1990; Petroni 1992). Our analysis is distinctive in using loss forecast revisions to measure price differences and in analyzing the relationship between loss forecast revisions and premium growth.

The moral hazard hypothesis predicts that firms with weak safety incentives will charge low prices and grow more rapidly than firms with higher target safety levels. The loss forecast revision for year t measures the extent to which an insurer subsequently updates its forecast of losses for accidents that occurred in year t. Forecast revisions will be influenced by unfavorable (or favorable) realizations in claim costs compared to full-information conditional expectations when policies are sold. Forecast revisions will be inversely related to price, assuming that firms that price low due to moral hazard deliberately understate initial reported loss forecasts to hide inadequate prices from regulators and other interested parties but that positive forecast revisions become inevitable as paid claims accumulate.[6] The percentage

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

5. Insurers that persisted in charging inadequate prices would either become insolvent or increase price and limit supply. Prior work suggests that sharp reductions in insurer capital could temporarily produce supra cost prices. While we do not analyze hard markets, inadequate prices due to moral hazard or heterogeneous information could contribute to erosion in capital and thus the severity of price increases in hard markets. In any case, if prices tend to become inadequate in the short run, they would eventually need to exceed costs in order for safer and better informed firms to make investments that generate quasi rents and earn fair rates of return over time.

6. Loss reserve reporting involves substantial managerial discretion. Failed insurers commonly have inadequate reported losses and loss reserves (see A.M. Best Co. 1991). This problem was pronounced for GL insurance written in the early 1980s by insurers that subsequently became insolvent (see U.S. House of Representatives 1990). Petroni

growth in premiums (net of reinsurance) for year t should be positively correlated with quantity growth (net of reinsurance) if firm-level demand is elastic. Thus, premium growth should be greater for firms that price low due to moral hazard and positively related to forecast revisions, reflecting demand response to low prices.

The heterogeneous information hypothesis predicts that firms with lower loss forecasts will charge lower prices and grow more rapidly than firms with higher forecasts. If prices vary due to differences in loss forecasts at the time of sale, less-informed firms should experience relatively greater upward forecast revisions over time as information accumulates. Hence, forecast revisions should again be inversely related to price; positively related to measures of poor information, such as inexperience; and positively related to premium growth.

We estimate reduced-form equations for loss forecast revisions and premium growth, including variables that measure propensity for low pricing due to moral hazard and heterogeneous information. We also estimate a structural model to test for a positive relation between premium growth and forecast revisions. Our results using GL insurance data during 1980–82 provide evidence that is consistent with low pricing due to moral hazard and inconsistent with low pricing due to heterogeneous information. The specific findings are as follows: (1) forecast revisions and premium growth were generally positively and significantly related to the amount of liabilities ceded to reinsurers, consistent with the moral hazard hypothesis that reinsurance was used to conceal low prices and excessive growth; (2) mutual insurers generally had significantly lower forecast revisions and premium growth than stock insurers, consistent with mutuals being less prone to low pricing due to moral hazard; (3) measures of experience generally were not significantly related to both forecast revisions and premium growth, contrary to the heterogeneous information hypothesis; and (4) premium growth was positively and significantly related to forecast revisions, consistent with an inverse relation between forecast revisions and prices. We also provide evidence of large unfavorable realizations in losses that were industrywide but more pronounced for reinsurers and insurers specializing in long-tailed GL sublines.

Section II provides background and summary data on industrywide GL insurance premiums, losses, and operating margins. Section III presents the models of inadequate prices. Section IV describes the empirical methodology and data. Section V reports results. Section VI concludes.

(1992) presents evidence that multiline loss forecast revisions by property-liability insurers are larger for financially weak insurers that may have greater incentive to understate initial forecasts.

II. General Liability Insurance Premiums, Losses, and Operating Margins

Standard financial theory predicts that break-even premiums equal the risk-adjusted discounted value of expected cash outflows for claims, sales expenses, income taxes, and any other costs (e.g., Myers and Cohn 1986). We use the term "perfect markets model" to refer to this model, with the additional assumptions (1) that expectations are conditional on all information available when policies are sold and (2) that insurer capital is sufficient to produce a low level of insolvency risk. This terminology encompasses the notion of market efficiency (prices reflect full-information conditional expectations) and insurance markets characterized by free entry, by perfectly elastic supply of capital at a cost commensurate with risk, and by sufficient incentives for insurers to operate with low insolvency risk.

In a strict sense, the hypothesis that insurance prices can be fully explained by the perfect markets model is surely false, given costs of information and adjusting supply. The key questions are whether prices deviate substantially from levels predicted by this model and, if so, what the causes of these deviations are. Answering these questions is difficult, however, because full-information conditional expectations, risk-adjusted discount rates, and other factors (such as expected cash flow patterns and tax liabilities) that affect break-even premium rates are unobservable. In particular, realized claim costs may differ substantially from full-information conditional expectations at the time of sale, and reported loss forecasts may be deliberately biased.

Figures 1 and 2 present aggregate industry data for 1976–89 to illustrate grounds for the debate over whether changes in GL premiums have been consistent with the perfect markets model and to provide background for our subsequent analysis. Figure 1 shows annual nationwide earned premiums net of insurer operating expenses (agents' commissions and other sales costs, including state premium taxes) in constant GNP-adjusted 1989 dollars.[7] It also shows, again in constant dollars, discounted forecasts of claim costs for accidents occurring during the year, using year-end ("initial") reported loss forecasts, and discounted forecasts of claim costs for accidents in the same years, using updated loss forecasts. The updated forecasts are those reported at year-end 1989 for accident years 1980–89 and at year-end 1985 (the latest available data) for accident years 1976–79.[8] Since coverage un-

7. Using gross national product (GNP) to obtain constant dollars adjusts for changes in the overall price level and possible changes in the demand for coverage as a function of overall economic activity.

8. Both the initial and updated loss forecasts were discounted by using an assumed cash flow schedule based on the claims payout pattern for accidents in 1980. As of year-end 1989, 11.8% of reported losses for accidents in 1980 were unpaid. A payout
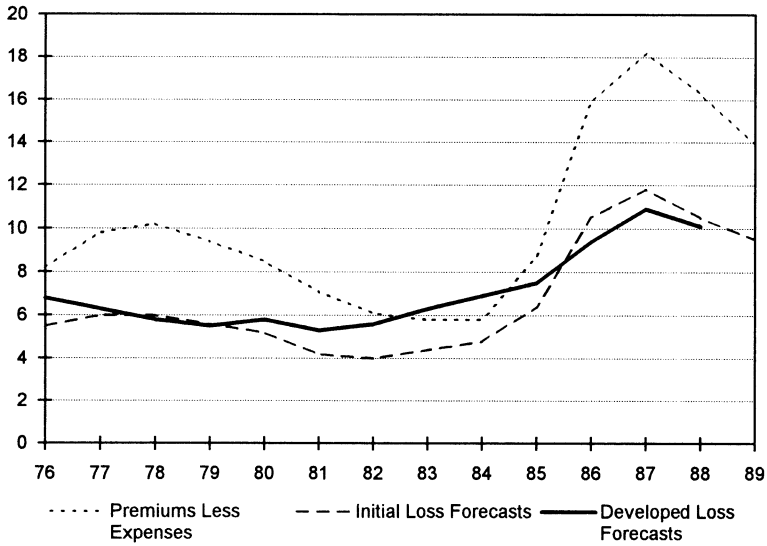
FIG. 1.—General liability insurance industry premiums less expenses, discounted initial loss forecasts, and discounted updated loss forecasts: 1976–89 (measured in billions of constant 1989 gross-national-product-adjusted dollars).
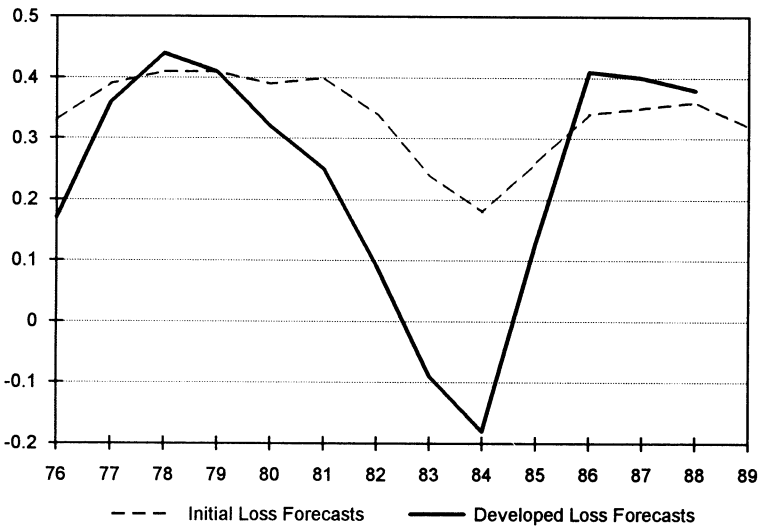
FIG. 2.—General liability insurance industry pretax operating margins, using discounted initial and discounted updated loss forecasts: 1976–89.

der policies sold in one year can extend into the next, claim costs for year t accidents arise from policies sold in years t and $t - 1$.[9] The discounted forecasts are only for accidents occurring in the year; that is, they do not reflect forecast revisions for accidents in other years. Discounting of loss forecasts controls for the predicted effects of interest rate changes on discounted expected costs and thus break-even premiums.

The perfect markets model implies that premiums less operating expenses should approximate forecasts at the time policies are sold of discounted expected claim costs and other costs (such as expected tax liabilities) not included in operating expenses. With accurate reporting, initial loss forecasts for year t would reflect expectations at the time policies were sold (in years t and $t - 1$), plus forecast revisions through year t. Updated loss forecasts would reflect revisions in forecasts between the time policies were sold and year-end 1989 (or year-end 1985 for accident years 1976–79). However, reported losses may deviate substantially from true loss expectations to the extent that insurers optimize loss reporting, given income tax rules and solvency monitoring by consumers and regulators (e.g., Weiss 1985), so that reported losses may deviate systematically from expectations.[10]

As shown in figure 1, discounted initial loss forecasts and premiums less operating expenses fell during the early 1980s and increased sharply in 1985–86. Increasing (decreasing) interest rates during the former (latter) period account for at least part of this movement. But premiums less operating expenses declined more rapidly than discounted initial loss forecasts during the early 1980s and increased more rapidly during 1985–86. Large upward forecast revisions occurred through 1989 for policies sold in the early 1980s. If, as is suggested by industry analysts, initial loss forecasts were deliberately understated during the early 1980s, reported forecast revisions would exceed true forecast revisions.

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pattern of .03, .026, .022, .02, and .02 was assumed for years 11–15. The reported loss forecasts include paid losses plus loss reserves, which represent insurer forecasts of the ultimate cost of unpaid claims for accidents in the year (including forecasts of claims for accidents as yet unreported). They also include paid and estimated unpaid claim settlement expenses.

9. The average yield on new issues of 5-year government bonds in years t and $t - 1$ was used to discount estimated future cash outflows for year t accidents. Similarly, the average operating expense ratio for years t and $t - 1$ was used to calculate approximate generally accepted accounting principles expenses, and average GNP for years t and $t - 1$ was used to calculate constant dollar amounts. "Earned" premiums (premium revenues from insurer income statements) are shown because they also correspond to policies sold in years t and $t - 1$. Changes in "written" premiums (less operating expenses), which represent cash inflows for policies sold during a given year only, were generally more pronounced than changes in earned premiums.

10. Note also that absolute differences between initial and updated loss forecasts could well be smaller toward the end of the period shown simply because the forecasts are updated for fewer years.

Figure 2 shows annual operating margins (premiums less operating expenses less discounted loss forecasts, as a proportion of premiums) for GL insurance using both initial and updated loss forecasts. The initial operating margins declined substantially in the early 1980s and increased substantially in 1985–86 in conjunction with premium increases. The updated margins declined each year during 1979–84. They are negative for 1983–84, suggesting that premiums turned out to be insufficient to fund operating expenses and claim costs, let alone cover other costs.

The aggregate data in figures 1 and 2 are at best suggestive. They could be consistent with the perfect markets model in conjunction with large unfavorable realizations in claim costs for accidents in the early 1980s and slow revisions in loss forecasts (Harrington 1988). A substantial shift in the loss distribution with slow learning might produce several consecutive years where ex post costs are much higher than ex ante full-information conditional expectations. Changes in risk-adjusted discount rates or other costs also might explain some of the variation in operating margins.[11] As noted, these accounting data also could be influenced by deliberate understatement or overstatement of loss forecasts to manage reported income. But an alternative view of these data is that premiums declined during the early 1980s relative to discounted expected costs, that some insurers deliberately understated initial loss forecasts to mask deteriorating financial results caused by underpricing, and that underpricing ultimately contributed to the sharp premium increases of 1985–86.

III.   Models of Inadequate Insurer Prices

Inadequate prices relative to ex ante full-information conditional expectations of claim costs would contradict the perfect markets model; apparent price inadequacy ex post due to unfavorable realization of claim costs would not. We model prices that are potentially inadequate ex ante by introducing two types of heterogeneity among firms: different incentives for solvency and differences in loss forecasts that arise from heterogeneous information. An important assumption is that demand of many buyers is insensitive to default risk because of guaranty fund protection, information costs, or both.[12] Different incentives for

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11. Evidence suggests that the market price of risk is positively related to interest rates (e.g., Ferson and Harvey 1991). If claim liabilities are positively correlated with aggregate returns on risky assets, risk-adjusted discount rates for losses could have increased more than yields on government bonds during the early 1980s when interest rates rose and less than bond yields when interest rates fell during 1985–86.

12. If low-price, high-default risk insurers simply attract less risk-averse customers from high-price, low-default risk firms, the notion of inadequate prices becomes more ambiguous.

solvency are suggested by work on insurer capital structure and default risk (e.g., Munch and Smallwood 1980, 1982). Industry analysts treat heterogeneity in loss forecasts for comparable risks as an accepted fact (e.g., Stewart 1984). Intuitive explanations of the basic results follow. Appendix A contains a formal model.

A. Moral Hazard

Some firms may price too low because of weak incentives for safety and the moral hazard (MH) that arises when liability is limited, when demand is invariant to default risk, and when guaranty fund assessments against insurers are risk insensitive. Willingness to incur risk will differ across firms, reflecting the value of nontransferable tangible capital (some physical assets) and intangible capital that would be lost from insolvency (Munch and Smallwood 1982; Finsinger and Pauly 1984; also see Herring and VanKudre 1987). Intangible capital consists of the value of reputation and any quasi rents on renewal business. Policyholder-specific intangible capital includes the investment in establishing a book of business, including the cost of attracting and screening a new policyholder. Depending on policyholder turnover, the optimal pricing strategy to recoup this investment may be to charge an initial price below the first-year marginal cost, inclusive of this fixed cost, and to price above marginal cost on renewal business. Common intangible capital reflects the firm's investment in reputation for a high-quality product (promptness in claims handling, provision of other services, or, if policyholders care, low insolvency risk).[13]

If a firm becomes insolvent, it loses its nontransferable tangible and intangible capital; that is, it loses its "franchise value." Shareholder wealth maximization implies that the firm's levels of financial capital and supply price are positively related to franchise value (see App. A). Firms with little franchise value have incentives to hold relatively little financial capital, price low, and have high insolvency risk. Alternatively, unfavorable realizations of claim costs or asset returns could lead to go-for-broke behavior in the form of low prices.

If some firms price too low, firms with significant intangible capital will optimally reduce price within some range to mitigate loss of customers and associated quasi rents that are earned if customers renew. Thus, inadequate prices for some firms could cause inadequate prices for other firms. The long-run equilibrium price for a firm is positively related to investments in nontransferable tangible and intangible capital and therefore must normally exceed the marginal per-policyholder

13. Klein and Leffler (1981) show that in markets for experience goods, firms that invest in reputation for high quality will tend to charge prices above marginal cost in order to recoup the cost of this investment. Similarly, the cost of fixed investments in physical capital, such as claims-processing facilities, may be amortized over several years and recovered by pricing above marginal claims cost.

expected loss and expense cost, in order to earn a normal return. In the short run it is optimal to cut price to retain business as long as price exceeds marginal cost, even if price is below the long-run equilibrium level.

The possibility that MH will cause some firms to charge low prices, gain market share, and have high default risk clearly is not unique to insurance. It is another case in which low quality drives out high quality when demand is insensitive to quality, due to either costly information or flat-rated insurance against the consequences of low quality. Characteristics that make liability insurance particularly vulnerable to MH-induced low prices include substantial, albeit limited, government-mandated guarantees of insurer obligations that were adopted in the early to mid-1970s and up-front payment of premiums coupled with average claim payout lags of 5 years or more on product liability and other long-tailed lines. In addition, losses fall on third-party claimants if the insurer defaults and the policyholder is judgment proof, and there exist formidable problems in regulatory detection and verification of inadequate prices or other forms of increased risk taking.

The MH hypothesis predicts that firms with weak safety incentives will charge low prices and grow more rapidly than firms with higher target safety levels. As noted earlier, loss forecast revisions will be positively related to MH-induced low prices, assuming that firms deliberately understate initial reported loss forecasts to hide inadequate prices from regulators but that positive forecast revisions become inevitable as paid claims accumulate (see n. 6 above). Premium growth should be positively related to forecast revisions, reflecting demand response to low prices. As we explain in Section IV below, possible indicators of propensity for low pricing due to MH are use of reinsurance, organizational form (stock vs. mutual), leverage, and investment mix.

B. Heterogeneous Information

With heterogeneous information (HI), some firms with optimistic private information on future claim costs may price too low relative to full-information conditional expectations and thus exert downward pressure on other firms' prices. In particular, HI could give rise to winner's curse effects, whereby some firms with optimistic information price too low, grow rapidly, and subsequently experience losses. Inadequate prices due to HI would be especially likely for inexperienced firms.

The sale of liability insurance to a unique risk is a form of common value auction. Public information for forecasting a risk's expected claim cost includes that provided by trade associations. Heterogeneous private information includes an insurer's own past experience on comparable risks. Basing prices (bids) only on the conditional forecast, given the insurer's private information and public information, will

expose the insurer to a winner's curse even if these conditional forecasts are unbiased. The reason is that the conditional expectation of loss given that the insurer sells the policy (i.e., has the lowest bid) exceeds the conditional forecast based on the insurer's private information and public information.

The winner's curse can be avoided if bidders adjust their bids given knowledge of the bidding processes used by other firms and the joint density of public/private information and expected loss costs. If all firms bid optimally, under certain assumptions the winning bid converges to the true value of the object being bid for as the number of bidders increases (Wilson 1977; Milgrom 1979). These assumptions are strong, and convergence need not occur in practice. Plausibly, established firms have learned to adjust their forecasts to avoid the curse. However, if inexperienced firms, such as new entrants, make inadequate adjustments, they will price too low and exert downward pressure on other firms' prices.

In markets for classes of homogeneous risks, which we model formally in Appendix A, rational behavior requires firms to infer other firms' information from market prices. This requires knowledge of the joint distribution of market prices and private information (e.g., Grossman 1981). Under certain conditions, prices obtained in a rational expectations equilibrium fully reveal diverse private information (e.g., Jordan and Radner 1982). The necessary assumptions are again strong and unlikely to hold in insurance markets characterized by large shifts in loss distributions over time. If inexperienced firms place too much emphasis on their own information or draw incorrect inferences from other firms' actions, such firms with low forecasts and thus low prices will tend to grow rapidly, experience large unfavorable forecast errors, and create downward pressure on prices of firms with higher forecasts.

Inadequate pricing due to HI is more likely when firm-level demand is elastic with respect to price but inelastic with respect to default risk, and when the market is characterized by easy entry and by slow resolution of uncertainty and thus slow learning about the accuracy of prior forecasts. Heterogeneity in forecasts will also be more pronounced when sources of information are diverse, when heterogeneous production or cost functions make it difficult to infer other firms' information, when the full-information conditional variance of claim costs is large, and when the effects of heterogeneity cannot be reduced by informed traders. Markets for long-tailed liability insurance exhibit most of these characteristics. In particular, both the mean and conditional variance of claim costs appear to have increased in the 1980s, making it more difficult to forecast losses.

The HI hypothesis predicts that firms with lower loss forecasts will charge lower prices and grow more rapidly than firms with higher forecasts and prices. Low forecast/price firms also will be more likely

to sell any coverage and thus more likely to appear in our database than high forecast firms. Low forecast/price firms should experience relatively greater upward forecast revisions over time as information accumulates. Again, premium growth should be positively related to forecast revisions. Since low prices due to HI are more likely for inexperienced firms, possible indicators of propensity for low pricing include recent entry into the GL market and specialization in GL, as we explain further in Section IV.[14]

IV. Empirical Methodology and Data

A. Loss Forecast Revisions and Premium Growth

The loss forecast revision in year t, %FR, equals the percentage difference between updated (through year $t + 5$) and initial (end-of-year t) loss forecasts for accidents in year t, net of reinsurance.[15] The %FR reflects revisions in reported estimates of the ultimate value of claims, including paid claims and the estimated value of unpaid claims (including claims incurred but not reported) between years t and $t + 5$. Premium growth, %GR, is the percentage growth in premiums written in year t, net of reinsurance.

As discussed above, firms that price low due to MH or HI should have larger values of %FR and %GR, other things being equal. In addition, if %FR is inversely related to price, %GR should be positively related to %FR. Apart from any MH or HI effects, %FR should reflect idiosyncratic and industrywide forecast error relative to full-information conditional expectations. The resulting differences across firms in %FR could reflect differences in business mix. Subsequent experience suggests that firms that specialized in risky long-tailed GL sublines would have large positive forecast revisions for policies sold during the early 1980s.[16] Differences in premium growth across firms also will reflect any shifts in demand for product offerings and possibly any differential growth in expected claim and other costs per unit of coverage.

We estimate reduced-form equations for %FR and %GR to test for MH and HI effects. We include variables that measure MH and HI

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14. The relationship between overall firm size and forecast revisions is ambiguous, as we explain in Sec. IV.

15. At the time of our data, insurers did not report comparable loss forecasts before reinsurance.

16. Differences in %FR across firms also will reflect any differences in incentives to manage (smooth) reported loss reserves (see Weiss 1985). Smoothing should be unrelated to price, unless it reflects MH or HI, in which case our interpretation remains valid. Differences in %FR that are unrelated to price should be unrelated to growth. Thus, it is unlikely that management of loss reserves would lead to a false diagnosis of low pricing and more rapid growth due to MH or HI in our empirical tests.

propensities and variables that could affect %FR and %GR apart from MH or HI. A variable that is negatively (positively) related to price due to either MH or HI should be significantly and positively (negatively) related to both %FR and %GR. Significance in only one equation would imply that a variable is unrelated to price and thus be inconsistent with MH or HI. We also estimate a structural model to test for a positive relation between %GR and %FR. As noted, our analysis assumes that matching price cuts by other firms do not eliminate cross-sectional price variation. By reducing price variation, price cuts by other firms in response to low prices due to MH or HI will reduce the power of our cross-sectional tests.

B. Moral Hazard Variables

Reinsurance. To test for low pricing due to MH, we include the ratio of reinsurance recoverable (on paid and unpaid losses and unearned premiums) to assets as a measure of the transfer of liabilities to reinsurers. Solvency regulation monitors insurers' policy-related liabilities net of reinsurance if the reinsurer meets minimum requirements. Thus, reinsurance enables insurers to reduce leverage (net of reinsurance) and to write more direct business, given their capital, without violating regulatory norms. The efficient hedging rationale for reinsurance purchases (Hoerger, Sloan, and Hassan 1990; Mayers and Smith 1990; Berger, Cummins, and Tennyson 1992) suggests that reinsurance demand will reflect the same determinants as the demand for insurance and other forms of corporate hedging. Nonetheless, reinsurance could also be used to conceal MH-induced low pricing, as is suggested by anecdotal evidence (see U.S. House of Representatives 1990).

General liability insurers wishing to price low and grow rapidly because of MH during the early 1980s would be likely to reduce the effects on premium growth net of reinsurance (and leverage) by reinsuring large amounts of business.[17] Much of this reinsurance would be expected to be purchased from low-quality reinsurers also subject to MH or to reduce growth and leverage without shifting significant risk to reinsurers.[18] However, given that the use of reinsurance to

17. This behavior could have become more prevalent after the adoption of government-mandated guarantees of direct insurance obligations in the 1970s, and in response to unexpected increases in claim liabilities and any resultant go-for-broke behavior. The intensity of reinsurance regulation has increased since the late 1980s, partly in response to the perception that reinsurance was being used to conceal risk taking

18. Some reinsurance arrangements allow insurers to increase reported capital by transferring undiscounted loss liabilities to reinsurers at prices that reflect discounting of these liabilities. Adiel (1993) discusses how these arrangements allow management of reported capital. Asymmetric information might also have enabled high-risk primary insurers to reinsure at prices unfavorable to reinsurers, but this scenario would require that reinsurers were unable to anticipate adverse selection.

conceal risk taking involves some cost (e.g., transaction costs and/or sharing of potential profits), insurers with low prices due to MH would be expected to have higher premium growth net of reinsurance than would higher priced firms.

Thus, under the MH hypothesis, extensive use of reinsurance should be related to low prices and thus positively related to both %FR and %GR. A positive relation between reinsurance and %FR is not an unambiguous indicator of MH. Insurers that specialized in high-risk GL sublines may have reinsured heavily for purposes of efficient hedging and may also have incurred relatively large unfavorable realizations in claim costs. But the business mix/hedging rationale does not predict systematically low prices and thus greater premium growth net of reinsurance for insurers with large amounts of reinsured liabilities. Positive correlation between direct (before reinsurance) premium growth and the use of reinsurance would be expected without MH because reinsurance can allow more direct business to be written safely without expanding capital proportionately. However, this function of reinsurance does not imply more rapid growth in premiums net of reinsurance.

Mutual organization. We include a binary variable equal to one for mutual organizations and zero for stock firms. Sublines of GL that are vulnerable to large forecast errors (e.g., product liability) generally entail substantial managerial discretion in pricing. Theories of organizational form (Mayers and Smith 1988; Lamm-Tennant and Starks 1993) and the limited ability of mutuals to raise capital predict that mutual insurers are less likely to write these risky lines. Thus, unobserved differences in business mix could produce a negative relation between mutual organization and %FR during a period characterized by large unfavorable realizations in claim costs. Under this perfect markets/business mix hypothesis, larger values of %FR for stock insurers would reflect larger unintended forecast error, not intentional low pricing. Therefore, more rapid growth for stocks than mutuals is not predicted.

Mutuals will be less likely than stocks to price low because of MH if managers (and possibly owner/customers) are averse to financial distress; that is, MH will be less severe for mutuals (Hansmann 1985; Garven 1987). Thus, like the perfect markets/business mix hypothesis, the MH hypothesis predicts that mutuals will experience lower %FR. However, since in this case lower %FR indicates higher prices, lower %GR for mutuals also is predicted. Lower growth is not expected if mutual organization is simply a proxy for specialization in low-risk lines.[19]

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19. It conceivably might be argued that the inability of mutuals to issue equity could lead to slower growth for mutuals during a period of rapidly increasing market demand. This argument would not predict slower GL premium growth for mutuals in the early 1980s when industry-wide premiums were declining relative to GNP.

Leverage and investment mix. Other risky strategies, such as operating with high financial leverage and/or holding a risky asset portfolio, could be correlated with intentional low pricing due to MH. The MH hypothesis suggests a possible nonmonotonic relationship between leverage and risk taking, and hence a nonmonotonic relationship between leverage, %FR, and %GR. Up to some level, increased leverage could discourage risk taking if firms try to protect their tangible and intangible capital. But if beyond a certain point, high leverage indicates little intangible capital or produces go-for-broke behavior, the effect of additional leverage on %FR and %GR should be positive.

The ratio of gross liabilities (net liabilities plus reinsurance recoverable) to assets and the square of this ratio are included to measure gross financial leverage. Given the inclusion of reinsurance recoverable to assets, the coefficients for leverage estimate the effect of increases in unreinsured liabilities. This leverage measure has several limitations: it will understate true leverage if an insurer understates its claim liabilities, it is based on book rather than market values of liabilities and some assets, and it does not reflect the capitalized value of quasi rents. The ratio of the market value of common stock investments to the book value of invested assets is included as a rough proxy for investment risk. Since the volatility of insurer accounting and, most likely, market returns increases with this variable, high values could indicate a propensity for high-risk behavior because of MH.[20]

C. Heterogeneous Information Variables

Entry. The HI hypothesis suggests that new entrants are more likely to price low on average due to optimistic forecasts and thus likely to have larger %FR and %GR.[21] Lower prices (larger %FR) and more rapid growth are predicted for recent entrants with no prior property-liability insurance experience than for established insurers entering GL that have prior experience in other lines. More rapid growth by new entrants also might be consistent with the perfect markets model. For example, an established firm with business in other lines might grow relatively rapidly on entering GL by marketing GL to its existing customers. However, the perfect markets model does not predict lower prices and thus higher %FR for entrants.

Two binary indicators of new entrants are included to test for low pricing due to HI. The GL entrant variable indicates a recent entrant

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20. Increases in interest rates during the sample period likely reduced the market value of equity for many insurers given the long duration of their bond portfolios. While this may have been associated with MH, including go-for-broke behavior, we were skeptical of developing a useful measure of interest rate risk using available data.

21. While we regard recent entry as primarily indicating possible effects of HI, new entrants also may have relatively less nontransferable tangible and intangible capital and thus may be more prone to MH.

to GL with experience in other lines. It equals one if the insurer did not write GL but did have positive net premiums written for other lines in 1976. The property-liability entrant variable equals one if the insurer had zero GL and zero other property-liability net premiums in 1976 or was not included in the data as of 1976.[22]

General liablility specialization. Holding total premiums constant, insurers that write a relatively large proportion of business in GL have greater line-specific experience in GL. Increased specialization in GL also would make GL pricing errors more costly, providing additional incentive to develop pricing expertise. Thus, the HI hypothesis implies that increased specialization in GL will be positively related to price and hence negatively related to %FR and %GR.

We include the ratio of GL net premiums written to total net premiums written in year $t - 1$ to measure specialization in GL. A negative coefficient for this variable in the %GR equation also might be consistent with life-cycle effects; that is, holding size (total net premiums) constant, firms with greater GL premium volume in year $t - 1$ could have slower GL premium growth in year t. We therefore include the ratio of total GL net premiums written from 1976 through year $t - 2$ ("prior" GL premiums) to total net premiums written in year $t - 1$ as an additional measure of experience in the GL equation. This variable might be less affected by life-cycle effects.

D. Other Variables

We include the log of assets in the %FR equation and the log of total net premiums written in the %GR equation to control for any size-related effects, recognizing that these variables are unlikely to provide unambiguous evidence of MH or HI. If small firms in the sample are more likely to have low forecasts because of inexperience, or have weaker incentives for safety due to lower intangible capital per unit of output, size should be negatively related to %FR and %GR due to HI and MH, respectively. However, if large firms typically write higher limits and riskier coverages than small firms, and these coverages experienced larger industrywide or idiosyncratic forecast errors during the early 1980s, these unobserved differences in business mix could lead to a positive relation between %FR and size. Thus, while a significant negative estimate for size in the %FR equation might provide strong evidence of low prices due to MH and/or HI, an insignificant or positive estimate would not be contradictory. In addition, simple

22. The A.M. Best tapes at the University of Pennsylvania contain data from 1976 onward. The number of entrants in the regression sample was small each year, ranging from 16 in 1980 to 25 in 1982. Entrants' share of GL net written premiums (before excluding extreme values, see below) ranged from 1.9 percent in 1980 to 3.6 percent in 1982.

life-cycle models of firm growth suggest that small firms will grow more rapidly than large firms for any given price.

Three variables are included as rough controls for insurer business mix. Binary variables indicate reinsurers and direct writers, as classified by the A.M. Best Company. Reinsurers commonly write high-limits, excess-of-loss coverage for GL. Since unfavorable realizations in claim costs have a much bigger effect on excess-of-loss than on primary coverage, %FR will likely be greater for reinsurers during the early 1980s. There are no strong predictions for direct writers versus independent agency insurers. Direct writers generally specialize in providing coverage to small to medium-sized businesses. The vulnerability of this coverage to large unfavorable realizations in claim costs might differ from coverage sold by independent agency insurers. Direct writers are likely to have greater intangible capital or firm-specific investments at risk. However, many independent agents also have intangible capital at stake that could cause them to avoid dealing with risky insurers. Relative growth rates for direct writers and agency insurers could vary for reasons unrelated to MH and/or HI (e.g., technological and demand changes that favor a particular distribution method). Finally, as a rough control for specialization in long-tailed lines of GL, we include the ratio of cumulative paid claims, as of year $t + 5$, for accidents in year t to the updated forecast, as of year $t + 5$, of losses for accidents in year t.[23] If longer-tailed risks experienced greater unanticipated shifts in the loss distribution, this variable will be negatively related to %FR.

E. Estimation Procedure and Data

We estimated the %FR and %GR equations using annual data for 1980, 1981, and 1982 for over 200 insurance company groups and unaffiliated companies that survived until 1985, 1986, and 1987, respectively. The variable %FR is only available for firms that survive through year $t + 5$. Results of additional tests (see App. B), including estimation of the %GR reduced form equation including firms that did not survive, suggest that survivor bias is unlikely to have a substantive impact on the reported results. We used weighted least squares to estimate the reduced-form equations and weighted two-stage least squares for the structural equation for %GR. Two-stage least squares was used in the latter case because %FR and %GR should be jointly determined if %FR reflects price differences and because %FR is a noisy measure

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23. For 1981 and 1982, we use the values of this ratio for accident years 1980 and 1981, respectively, to reduce possible spurious correlation between this variable and %FR. Since we did not have data on updated accident-year loss forecasts for 1979, for 1980 we use the value of the ratio for 1980. Similar results were obtained when this variable was omitted.

TABLE 1   **Mean and Tenth-, Twenty-fifth-, Fiftieth-, Seventy-fifth-, and Ninetieth-Percentile Values of Cross-sectional Distributions of Loss Forecast Revisions (%FR) and Growth in Net Premiums Written (%GR)**

Variable and Statistic	1980 (%)	1981 (%)	1982 (%)
Loss forecast revision (% FR):			
Mean	18.6	29.3	39.0
90	74.2	110.6	119.6
75	36.1	38.3	61.9
50	7.4	11.3	19.9
25	−11.7	−11.6	−8.1
10	−30.1	−27.0	−26.1
Growth in net premiums written (%GR):			
Mean	1.5	2.0	1.7
90	31.6	28.4	31.1
75	9.8	9.7	9.9
50	.4	−3.8	−3.2
25	−10.5	−16.0	−14.5
10	−21.8	−27.1	−38.6
N	238	242	245

NOTE.—%FR is the percentage change in the reported loss forecast for accidents in year t between years t and $t + 5$; %GR is the percentage change in net premiums written between years t and $t - 1$.

of price. The weights used to control for heteroscedasticity are related to size in the %GR equation and to GL premium volume and the reinsurer and mutual dummies in the %FR equation. Unweighted data produced similar results. Unless otherwise noted, all regressors are lagged 1 year relative to the dependent variable. Estimation methods and data sources are described further in Appendix B.

V. Empirical Results

Table 1 shows means and selected percentile values of the cross-sectional distributions of annual values of %FR and %GR during 1980–82. The data on %FR indicate substantial and increasing forecast revisions over the period. For 1982, the mean and median %FR were 39% and 20%, respectively, compared to 19% and 7% in 1980. While low initial loss forecasts and positive forecast revisions are consistent with MH or HI, the large magnitude of the mean and median values of these revisions suggests large and industry-wide unfavorable realizations in claim costs.

Table 2 reports the reduced-form %FR and %GR equations. Overall, the results provide evidence of low pricing due to MH but not due to HI. The estimated coefficient for the ratio of reinsurance recoverable

TABLE 2   Cross-sectional Tests for Moral Hazard and Heterogeneous Information
Effects on Loss Forecast Revisions (%FR) and Growth in Net
Premiums Written (%GR)—Weighted Least-Squares Estimation of
%FR and %GR Reduced-Form Equations

Variables	1980		1981		1982	
	%FR	%GR	%FR	%GR	%FR	%GR
A. Moral hazard:						
Intercept	1.120	.648	1.804	.575	2.452	.772
	(1.68)	(1.63)	(1.87)	(1.40)	(2.88)	(2.17)
Reinsurance						
recoverable/assets	1.639	.572	.588	1.029	2.654	.587
	(3.05)	(1.94)	(.86)	(3.37)	(4.06)	(2.01)
Mutual	−.142	−.075	−.372	−.130	−.264	−.030
	(−2.06)	(−1.81)	(−3.90)	(−2.92)	(−2.93)	(−.71)
Liabilities/assets	−.601	−.121	−1.856	−.470	−1.621	−1.241
	(−.62)	(−.14)	(−1.71)	(.96)	(−1.50)	(−2.66)
(Liabilities/						
assets) squared	−.250	−.049	1.047	.029	−.008	.391
	(−.40)	(−.14)	(1.53)	(.09)	(−.01)	(1.24)
Common stocks/						
invested assets	−.086	−.194	.288	.035	.076	−.001
	(−.26)	(−1.07)	(.73)	(.20)	(.21)	(−.01)
B. Heterogeneous						
information:						
GL entrant	−.146	−.086	−.284	.325	−.053	.383
	(−.70)	(−.82)	(−.92)	(2.45)	(−.21)	(3.50)
PL entrant	−.174	.091	−.372	.104	−.000	.295
	(−1.10)	(.97)	(−3.90)	(1.12)	(−.00)	(3.73)
GL premiums/						
total premiums	−.148	−.132	−.444	−.381	−.160	−.609
	(−.84)	(−.81)	(−1.81)	(−2.33)	(−.70)	(−3.84)
Prior GL premiums/						
total premiums	...	−.126	...	−.027	...	.110
		(−1.52)		(−.60)		(3.70)
C. Control:						
Log of assets	−.017	...	−.035	...	.006	...
	(−.72)		(−1.03)		(.20)	
Log of total net						
premiums written	...	−.021	...	−.021	...	−.005
		(−1.61)		(−1.37)		(−.36)
Reinsurer	.426	−.002	.558	−.093	.603	.042
	(2.76)	(−.04)	(2.70)	(−1.28)	(3.53)	(.66)
Direct writer	−.039	.075	.054	.108	−.048	.047
	(−.53)	(1.72)	(.53)	(2.21)	(−.49)	(1.02)
Cumulative paid/						
updated loss fore-						
cast	−.185	−.100	−.092	.126	−1.412	−.040
	(−.70)	(−.72)	(−.25)	(.79)	(−4.45)	(−.30)
N	237	234	240	240	244	244

NOTE.—%FR and %GR were divided by 100 prior to estimation. Regressors are based on data available at the beginning of the year ($t − 1$), except for cumulative paid/updated loss forecast for 1980, which reflects data at year-end 1980. "Prior GL premiums" denotes general liability premiums from 1976 through year $t − 2$. PL = property-liability. The weights used are described in Appendix B. Values in parentheses are *t*-statistics.

to assets is uniformly positive in both the %FR and %GR equations and generally significant. This result supports the MH hypothesis that reinsurance was used to conceal low prices and excessive growth. It seems unlikely that the positive effects in both equations are due instead to possible correlation between the use of reinsurance and specialization in coverage that experienced large shifts in the loss distribution. This alternative explanation does not explain the relationship between reinsurance and premium growth (net of reinsurance). The findings for mutuals also provide some support for the MH hypothesis. Mutuals had lower estimated %FR and %GR in all 3 years. The estimates for %FR are significant in all 3 years, and the estimated growth differential is significant at the .05 level for a one-tailed test for 2 of the 3 years. While lower %FR for mutuals could be influenced by specialization in less risky GL lines, risk specialization cannot readily explain lower %GR for mutuals.

Leverage (liabilities/assets), leverage squared, and the common stock ratio are generally insignificant in both equations. These results suggest that any low pricing due to MH was not related to these variables. As noted earlier, however, if firms attempted to conceal intentional risk taking by underreporting liabilities, reported leverage contains measurement error that will tend to bias against finding the correlation expected under the MH hypothesis. The common stock ratio also is an imperfect indicator of investment risk.

The results generally do not support the hypothesis of low pricing due to HI. While there is some evidence that new entrants grew more rapidly (three of the six coefficients for entrants are positive and significant in the %GR equations), entrants did not experience larger forecast revisions, as expected if higher growth was induced by lower prices. This suggests that the more rapid growth of entrants was attributable to life-cycle effects rather than low prices. The ratio of GL premiums to total premiums is negatively and significantly related to %GR in 1981 and 1982, which is consistent with the hypothesis that firms with less GL experience grew more rapidly. However, since the estimated relationship is negative but not significant in the %FR equation, the relationship in the %GR equation may more likely be due to life-cycle effects than to systematic underpricing. The erratic results for cumulative prior GL experience are also inconsistent with the HI hypothesis.

The results for reinsurers are consistent with large unfavorable realizations in claim costs. When other characteristics are controlled for, reinsurers experienced larger upward revisions in loss forecasts, with the estimated differential increasing from 43% in 1980 to 60% in 1982. The fact that reinsurers did not grow more rapidly suggests that larger forecast revisions were not caused by low prices due to MH or HI. The large negative coefficient for the ratio of cumulative paid losses

TABLE 3   Cross-sectional Tests for a Relationship between Growth in Net
Premiums Written (%GR) and Loss Forecast Revisions (%FR)—
Weighted Two-Stage Least-Squares Estimation of %GR Structural
Equation

	1980	1981	1982
Intercept	.408	−.025	.060
	(1.15)	(−.04)	(.16)
Loss forecast revision (%FR)	.303	.526	.190
	(2.24)	(3.31)	(2.30)
Log of total net premiums written	−.018	−.013	−.019
	(−1.28)	(−.55)	(−1.35)
GL premiums/total premiums	−.221	−.218	−.200
	(−1.93)	(−1.14)	(−1.64)
GL entrant	−.020	.527	.349
	(−.18)	(2.48)	(2.89)
PL entrant	.165	.051	.209
	(1.76)	(.38)	(2.53)
Mutual	−.019	.071	.020
	(−1.41)	(.75)	(.40)
Reinsurer	−.130	−.366	−.057
	(−1.37)	(−2.61)	(−.63)
Direct writer	.078	.071	.063
	(1.71)	(.94)	(1.25)
Cumulative paid/updated loss forecast	−.093	.145	.255
	(−.62)	(.56)	(1.36)
N	234	240	244

NOTE.—%FR is treated as endogenous; %GR should be positively related to %FR if %FR is inversely related to price. Regressors are based on data available at the beginning of the year ($t − 1$), except for cumulative paid/updated loss forecast for 1980, which reflects data at year-end 1980. Data are weighted by the square root of log GL (general liability) net premiums written in year $t − 1$. PL = property-liability. Values in parentheses are t-statistics.

to updated loss forecasts (an inverse proxy for firms specializing in long-tailed business) in the %FR equation but not the %GR equation for 1982 also suggests large industywide forecast errors on long-tailed business. The coefficients on the size and direct writer variables generally are insignificant, as expected if these variables reflect several factors with offsetting effects.

Table 3 reports weighted two-stage least-squares estimates of the structural equation for %GR, treating %FR as endogenous. Leverage, reinsurance recoverable to assets, and common stocks to assets are identifying predetermined variables. This equation allows a test of whether %FR reflected price differences that in turn affected growth rates. %GR is significantly and positively related to %FR in all three years, consistent with %FR being inversely related to price.[24] This

24. The results for this variable were somewhat sensitive to the inclusion of several (two to four) potential outliers each year. When these observations were excluded, the coefficients and t-values for %FR in the premium growth equation were .163 (1.33) for 1980, .867 (1.73) for 1981, and .319 (2.71) for 1982.

result cannot be readily explained by unfavorable realizations in claim costs that are unrelated to price. It is consistent with the hypothesis that some firms charged lower prices due to either MH or HI, experienced large upward forecast revisions, and grew more rapidly.

VI. Conclusions

Our theoretical analysis suggests that moral hazard can lead insurers with few assets at risk to price too low. We also have analyzed how low prices might arise from heterogeneous information across firms. In either case, firms that price too low will gain market share (assuming other firms do not fully match the price cuts), unless policyholders understand and internalize the risks, which is unlikely because of guaranty fund protection and information costs. Inadequate prices by some firms may cause other firms to cut price to retain business that yields quasi rents in future periods. Thus, inadequate pricing by some firms can induce inadequate pricing by other firms in the short run.

Our empirical analysis uses loss forecast revisions (which should be inversely related to prices) and premium growth net of reinsurance for GL during 1980–82 to test for evidence of moral hazard and heterogeneous information effects. Our results provide evidence of low pricing due to moral hazard but not due to heterogeneous information. The reduced-form results suggest that some insurers used reinsurance to conceal low prices and excessive growth. Forecast revisions and premium growth were significantly and positively related to the amount of liabilities ceded to reinsurers, controlling for the influence of other firm characteristics. The former result also could reflect efficient hedging, by reinsuring sublines of GL that were more vulnerable to unfavorable realizations in claim costs. However, efficient hedging and the expected effects of reinsurance on direct premium growth (before reinsurance) cannot readily explain the positive relationship between the use of reinsurance and premium growth net of reinsurance. The results also suggest that mutual firms, which should be less subject to moral hazard, maintained higher prices and grew less rapidly. Forecast revisions and premium growth were significantly smaller for mutuals. The former result could indicate specialization by mutuals in less risky sublines of GL (see Lamm-Tennant and Starks 1993), but risk specialization cannot readily explain slower premium growth for mutuals.

Our structural equation results provide evidence of a significantly positive relationship between premium growth and loss forecast revisions. This evidence is consistent with the hypothesis that forecast revisions are inversely related to prices due to either moral hazard or heterogeneous information. However, the reduced-form results provide little evidence that inexperience contributed significantly to inade-

quate pricing and rapid growth. New entrants and firms with relatively low premium volume in GL generally did not experience both larger forecast revisions and more rapid growth, as expected under the heterogeneous information hypothesis. Other findings are consistent with substantial unanticipated shifts in the underlying loss distribution that produced large industry-wide forecast errors, particularly for reinsurers and for insurers specializing in long-tailed GL sublines.

Our findings regarding moral hazard—and the possibility that inadequate prices due to moral hazard contributed to subsequent insolvencies and to the hard market of 1985–86—support increased concern by policy makers with regard to intentional risk taking and the use of reinsurance and underreporting of loss reserves to mask high-risk behavior. Future research may be able to develop better measures of propensity for low pricing and other forms of intentional risk taking, of inexperience, and of competitors' responses and thus help better distinguish these influences during soft markets. As noted earlier, any tendency toward inadequate pricing in insurance markets cannot continue indefinitely; soft markets must eventually be followed by harder markets. Another important area for future research is the transition from soft to hard markets and whether the alternation of soft and hard markets is in fact a self-generating cycle.

Appendix A

An Illustrative Model

We consider a monopolistically competitive insurance market with limited liability and claim risk that cannot be eliminated by writing a portfolio of policies. The monopolistic competition model allows for price variation and for some degree of brand loyalty. Consumers do not necessarily buy from the lowest-priced insurer, but they can be attracted to another insurer by a low enough price. Limited liability, undiversifiable claim risk, and heterogeneity in either intangible capital or loss forecasts produce endogenous default risk and differences in pricing incentives across firms. Our basic approach extends the model of Finsinger and Pauly (1984) by allowing for firm heterogeneity and for firm price and thus output to be endogenous.

Firm demand $q(p, s)$ depends on own price p and the price of a representative other firm s, with $q_p < 0$, $q_s > 0$, and $q_{ps} \geq 0$. At time 0 the firm chooses p, invests financial capital of k per policy, and incurs nonloss operating costs of $C(q)$, with $C' > 0$, and $C'' > 0$. It pays claims at time 1. Demand is insensitive to default risk ($q_k = 0$). The firm has intangible capital A, which is invested at time 0 and is marketable prior to investment. On the basis of Finsinger and Pauly (1984), firms cannot add financial capital after claims are realized. Comparable results can be obtained as long as adding financial capital at time 1 is more costly than at time 0 if funds are insufficient to pay claims at time 1. If premiums and financial capital equal or exceed claim costs at time 1,

residual claimants receive A and any excess funds. If not, the firm defaults and forfeits A. The key results only require that A decline if premiums and financial capital are less than claim costs.

Firms maximize the net present value of residual claims. Residual claimants are risk neutral, and the interest rate is zero. Investing financial capital incurs a cost (e.g., due to tax effects, as in Myers and Cohn 1986) at time 0 of τ per dollar invested. At time 1 the mean loss per policy sold is x with cumulative distribution function $F(x)$, reflecting risk that remains after the insurer writes a large portfolio of policies. This undiversifiable risk at the firm level could be caused by parameter uncertainty or correlation in losses across policies. Firms sell enough policies to eliminate idiosyncratic risk via the law of large numbers so that $F(x)$ does not depend on q.

Consider first the case in which all firms know $F(x)$ at time 0. A given firm correctly perceives that it will default if $x > p + k$ with probability $1 - F(p + k)$. If $x \geq p + k$, the firm is worthless to residual claimants; if $x < p + k$, its value is $A + (p + k - x)q(p, s)$. The firm chooses p and k to maximize expected net present value (dropping arguments of the demand function):

$$V = \int_0^{p+k} [A + (p + k - x)q]f(x)dx - C(q) - (1 + \tau)kq - A.$$

This can be written

$$V = qm - C(q) - [1 - F(p + k)]A, \qquad (A1)$$

where

$$m = \int_0^{p+k} (p + k - x)f(x)dx - (1 + \tau)k \qquad (A2)$$

is the expected margin between p and per-policy claim and capital costs. From (1), policies will have zero expected net present value if

$$m = \frac{C(q)}{q} + \frac{[1 - F(p + k)]A}{q}, \qquad (A3)$$

that is, the expected margin m between p and per-policy claim and capital costs must equal average operating costs plus the expected loss of A (per policy) from default.

The first-order conditions are

$$V_P = q_p m + q m_p - C'(q)q_p + f(p + k)A = 0, \qquad (A4a)$$

and

$$V_k = q m_k + f(p + k)A = 0, \qquad (A4b)$$

where $m_p = F(p + k)$, the probability of survival, and $m_k = F(p + k) - (1 + \tau) < 0$. The second-order conditions are $V_{pp} < 0$, $V_{kk} < 0$, and $V_{pp}V_{kk} - V_{kp}V_{pk} > 0$.

The first two terms in (A4a) give the expected reduction in qm from an increase in p. The last two terms give the expected reduction in operating costs and the expected cost of forfeiting intangible capital. Since qm_p and $f(p + k)$ are positive and $q_p < 0$, (A4a) requires $m > C'(q)$. When $A = 0$, V_k is negative ($m_k < 0$) for any value of k, and the firm will not commit financial

capital. If $A > 0$, the firm has an incentive to commit financial capital to reduce the likelihood that it forfeits its intangible capital.

Comparative statics for this model (available from us) give $p_A > 0$ and $k_A > 0$. Hence, larger intangible capital leads to greater financial capital, higher prices, and lower default risk. An important implication is that if A differs across firms, high A firms are vulnerable to low prices charged by low A firms. Unless some consumers have a strong preference for high A firms, low A firms would be expected to dominate the market over time. Similarly, if exogenous influences led to a sharp reduction in A, a firm's optimal price (and financial capital) would drop significantly, so that it might go for broke.

To introduce differences in loss forecasts across firms, consider a firm whose estimate differs from the mean loss by θ in each state of the world; that is, it assumes that the mean loss is given by $y = x + \theta$ with $g(y) = f(x)$ and $E(y) = E(x) + \theta$. The firm believes that it will forfeit A if $y > p + k$, which implies $x > p + k - \theta$. The firm's (perceived) expected net present value to residual claimants is then given by (A1) with y replacing x. After performing the change of variable $y = x + \theta$, the expressions for V, m, V_p, and V_k are identical to (A1)–(A4) except that $x + \theta$ replaces x and $p + k - \theta$ replaces $p + k$.

Comparative statics indicate that $p_\theta > 0$; the sign of k_θ is ambiguous. Thus, firms with loss forecasts lower than $E(x)$ ($\theta < 0$) charge lower prices. Such firms also perceive that they break even ($V = 0$) at a lower price. If the distribution of θ across firms has mean zero and is symmetrically distributed, the model suggests that the average price will be less than if all firms know the true distribution of mean loss since firms with negative θ will sell more coverage than firms with zero or positive values. The more elastic is firm demand, the greater would be the downward pressure on average price. Another implication is that firms with $\theta < 0$ would be more likely to sell any coverage than firms with $\theta > 0$, at least in the short run.

The optimal adjustment of p to a change in the price of another firm depends on the sign of V_{pk}, which is ambiguous if $A > 0$. However, if k is held constant, then $p_s > 0$, decreases in prices charged by other firms reduce a firm's optimal price. Once the firm has invested A and incurred operating costs of $C(q)$, a reduction in output by one unit reduces the expected net present value of the firm by $m > 0$, where m is increasing in A (see eq. [A3]). Thus, the firm has an incentive to cut price to preserve m. Price cuts are more likely if the firm can selectively cut price only to customers with relatively elastic demand. Finally, with policy-specific intangible capital, intuition suggests that firms would have additional incentive to cut prices to avoid losing quasi rents on established business.

Appendix B

Further Details on Data and Estimation

Data used to calculate %FR and the ratio of cumulative paid losses to updated loss forecasts were Schedule P data provided by the National Association of Insurance Commissioners (NAIC). Written premium data and data for the exogenous variables were obtained from A.M. Best data tapes maintained by the Center for Research on Risk and Insurance at the University of Pennsylva-

nia. The NAIC data for individual companies with common ownership were consolidated to a group basis using A.M. Best group definitions. All groups or unaffiliated companies with at least $250,000 in net premiums written for the regression sample year and the prior year were eligible. Observations with implausibly large values for any of several variables were excluded. The thresholds used were 10, for the firms' initial and updated loss forecast divided by earned premiums, the difference between these ratios, and %FR (divided by 100); and 15, for percent growth (divided by 100) in net or direct general liability premiums.

Regression diagnostics were calculated for initial specifications using the SAS "Influence" option (see Belsley, Kuh, and Welsch 1980). A number of influential observations were identified and excluded, primarily on the basis of either large studentized residuals (e.g., absolute value greater than 7), large standardized changes in an estimated coefficient when an observation was deleted from the sample (e.g., absolute value greater than 1.5), or both. Unless otherwise noted, these exclusions did not have a strong effect on the key variables related to the MH and HI hypotheses. The exclusions generally mitigated positive skewness in the ordinary least squares (OLS) residuals for the reduced forms. We also estimated some of the equations using logarithms of the endogenous variables and obtained essentially similar results.

To control for heteroscedasticity when estimating the reduced-form %FR equation, we assumed that $\log(\sigma^2) = a + b(1/P) + cR + dM$, where σ^2 is disturbance variance, P is earned GL premiums (net of reinsurance), R is a zero-one dummy variable equal to one for reinsurers, and M is a zero-one dummy variable equal to one for mutuals. We used the logs of the squared OLS residuals to estimate parameters and calculate appropriate weights for weighted least squares estimation. This procedure constrains the estimated variances to be positive. The estimates of b and c were generally positive and significant; the estimate of d was usually negative and significant. In the %GR equations, we assumed that disturbance standard deviation was proportional to the log of lagged GL insurance premiums written. Results using unweighted data were similar.

We estimated the %GR reduced-form equation for a sample that included firms that later failed. The estimates produced comparable results, suggesting that survivor bias is not serious. We also estimated the %GR equation including several alternative dummy variables for firms that later exited. The estimated coefficients were generally small and insignificant. This result suggests that factors leading to firm-specific financial problems, including effects of MH and HI, were captured by the remaining variables or that rapid growth by some firms in our sample that subsequently went insolvent was at least partially offset by slow growth for others that were already retrenching.

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