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The Impact of Firm Risk on Property-Liability Insurance Prices

David W. Sommer

ABSTRACT

This article examines the impact of an insurer's level of insolvency risk on the prices the insurer obtains for its products in the property-liability insurance market. The measures of insolvency risk used are those implied by the option pricing model of insurance. The key finding is the existence of a negative relation between insolvency risk and insurance prices. This implies that property-liability insurers are penalized for default risk through lower prices, despite the existence of guaranty funds. Other firm-specific determinants of insurance prices are also identified. The results have significant implications for insurance researchers and regulators.

INTRODUCTION

Traditional actuarial methods of pricing property-liability insurance have valued insurance apart from any financial market considerations. In the 1970s, researchers began to address this deficiency in insurance pricing models by using finance theory to investigate the insurance valuation problem in a market context. Models of this genre have come to be known as financial pricing models of insurance. Over the years, an extensive body of literature has developed in the area of financial pricing of insurance.

The earliest financial pricing models of insurance used the capital asset pricing model as a basis (Cooper, 1974; Biger and Kahane, 1978; Fairley, 1979; and Hill, 1979). Kraus and Ross (1982) later attempted to generalize these earlier models by applying arbitrage pricing theory to insurance. Myers and Cohn (1987) address the issue by using discounted cash flow techniques. Doherty and Garven (1986) and Cummins (1988) use modern option pricing theory to develop financial pricing models of insurance.[1]

David W. Sommer is Assistant Professor of Risk Managment and Insurance in the Terry College of Business at the University of Georgia.

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[1] A more complete review and analysis of the various financial pricing models of insurance is found in Cummins (1992).

A significant deficiency of most of the financial pricing models of insurance mentioned above is the lack of recognition of default risk. The value of an insurance policy to the policyholder is clearly dependent upon whether the insurer is solvent when the policyholder makes a claim. Thus, it seems desirable that a valuation model for insurance incorporate firm default risk into the pricing of insurance. This issue has been addressed with the models of Doherty and Garven (1986) and Cummins (1988), which incorporate default risk by using option pricing theory to value insurance.

A key implication of the option-based models of insurance valuation is that, like the value of risky corporate debt, the value of insurance policies should be negatively correlated with the level of insolvency risk of the issuing firm. The empirical question is whether market prices for insurance reflect this hypothesized negative correlation. The empirical results of this article provide evidence that such a relationship does exist. This finding of a negative relation between insurance prices and insurer default risk has several important implications. First, it means that market discipline currently exists in insurance markets. Since prices reflect risk, insurers have nonregulatory incentives to control their insolvency risk. It also demonstrates that the market recognizes the incompleteness of the current guaranty fund system. Additionally, as explained in more detail below, it provides another argument for the implementation of risk-based guaranty fund premiums. Finally, it shows the importance of incorporating default risk in theoretical financial pricing models of insurance.

Some previous evidence to support the hypothesis that insurance prices reflect firm default risk can be found in Berger, Cummins, and Tennyson (1992) and Cummins and Danzon (1995), although the focus of these articles is quite different from that of this study. The purpose of this article is to directly test the hypothesis that safer firms command higher prices in the property-liability insurance market. The measures of insolvency risk used are those implied by the option-based model of insurance. These measures more completely reflect default risk than the measures used in the above articles.

The following section briefly reviews a theoretical model of insurance prices developed in Cummins (1988) and Cummins and Sommer (1996). Then, after a discussion of the implications of the theoretical model, the results of empirical analysis designed to test these implications are presented.

The Theoretical Model

The basic option pricing model for insurance has been developed elsewhere (see Cummins, 1988, and Cummins and Sommer, 1996). The model yields formulae for the value of insurer equity and the value of insurer liabilities. Since the focus of this article is on insurance prices, the interest here is in the value of insurer liabilities. The value of these liabilities represents the market value of insurance to policyholders. The formula for the value of insurance, D, can be written as follows:

$$D = Le^{-r^{*}\tau} - \text{Put}\,(A, L, \sigma, \tau), \qquad (1)$$

where A = assets,
L = liabilities,
r^* = the risk-free interest rate, r_f, minus the inflation rate for insurance liabilities, r_L,
σ^2 = the insurer's risk parameter = $\sigma_A^2 + \sigma_L^2 - 2\rho\sigma_A\sigma_L$, and
Put $(A, L\ \sigma, \tau)$ = a standard put option with an exercise price of L, volatility parameter σ, and time to expiration τ.

Thus, the value of insurance is simply the discounted value of nominal liabilities minus a put option. This put option, which will be referred to as the insolvency put, completely captures the insolvency risk of the firm. The greater the insolvency risk, the greater the value of the insolvency put and thus the lower the value of the insurance.[2] If insurance prices reflect the true value of the insurance purchased, then riskier firms should receive lower premiums for their insurance than safer firms.

One key factor that has been ignored so far is the existence of guaranty funds. Guaranty funds are established by states to reimburse the claimants of insurers that become insolvent. If guaranty funds provide complete protection for policyholders, then the funds will make policyholders indifferent to the default risk of their insurer. Thus, unlike the case without guaranty funds, prices will not be affected by firm risk. It makes no difference to policyholders whether their losses are paid by a solvent insurer or by a guaranty fund. In the notation used above, complete guaranty funds alter the formula for D so that it becomes

$$D = Le^{-r^*\tau}. \tag{2}$$

This value of D is independent of firm insolvency risk.

Since guaranty funds exist in all U.S. jurisdictions, the above would seem to imply that insurance prices in the United States should not reflect insurer insolvency risk. However, this result was based on the assumption that guaranty fund protection is complete. In reality, guaranty funds are less than complete in the sense described above for several reasons.[3] First of all, guaranty funds do not cover all lines of insurance. For those lines that are covered, the funds generally have deductibles and upper limits on the amount they will pay on each policy, regardless of the contractual provisions of the policy.

Additionally, there may be delays in payments from guaranty funds compared to the timing of those same payments from a solvent insurer. This imposes a cost on the policyholders due to the time value of money. Also, guaranty funds

[2] Specifically, straightforward comparative static analysis demonstrates that holding all else constant, a decrease in the capital ratio or an increase in portfolio volatility lowers the value of insurance. Since capital ratio and portfolio risk are the two key determinants of insurer insolvency risk, these comparative statics demonstrate that higher firm default risk yields lower insurance values.

[3] See Duncan (1984) for an assessment of the current guaranty fund system.

may be expected to be stricter in the granting of coverage of a loss or the determination of the dollar amount of a claim. Exact terms of coverage are stated in the policy, but there is often considerable room for judgment in ambiguous situations. Since guaranty funds have no customer relationships to maintain, they are likely to be more conservative in their interpretations of ambiguous situations than a solvent insurer.

Finally, it is unclear that guaranty funds will always be able to meet their obligations. With rare exceptions, the state guaranty funds work on a post-assessment basis, and there are in most cases upper limits on the amounts that solvent firms can be assessed. Unlike federal deposit insurance for banks, insurance guaranty funds do not have the taxing power of government to back them up. For all these reasons, as well as the fact that many people may simply not know about the existence of guaranty funds, policyholders are unlikely to be indifferent between their insurer remaining solvent or going bankrupt. Thus, guaranty funds as they are currently formulated should almost surely be considered incomplete.

With incomplete guaranty funds, insurance prices are no longer independent of firm insolvency risk. However, customers will not demand a full default risk discount equal to the put value of the firm, as they do with no guaranty funds. As in Cummins and Sommer (1996), the various aspects of the incompleteness of guaranty funds will be incorporated into a single parameter, θ. It is assumed that policyholders consider every one dollar in liabilities from a solvent insurer to be equivalent to only $(1 - \theta)$ dollars if the loss is assumed by guaranty funds. Thus, if a firm is insolvent at time T, payoffs to policyholders are considered to be $A_T + (1 - \theta)(L_T - A_T)$. This compares to a payoff of A_T with no guaranty funds and L_T with complete guaranty funds.

Now the value of insurance can be expressed as follows:

$$D = Le^{-r^{*}\tau} - \theta \text{ Put}(A, L, \sigma, \tau). \qquad (3)$$

As can be seen, insurance values have an insolvency risk discount of θ times the put value, since policyholders retain θ percent of the burden of a default. This formula reduces to the special cases of no guaranty funds and complete guaranty funds by setting θ equal to one or zero, respectively.

This provides an intermediate case between no guaranty funds and complete guaranty funds, and clearly most reflects reality. The key point to note is that with incomplete guaranty funds, as with no guaranty funds at all, prices should reflect firm insolvency risk.

THE EMPIRICAL MODEL

From the previous section, some testable hypotheses can be formulated regarding the determinants of property-liability insurance prices. After describing an empirical measure of insurance prices, this section develops an equation to be used to empirically test those hypotheses.

The dependent variable in the equation to be estimated is PRICE. The measure of price to be used for empirical tests is based on the work of Winter

(1991), Berger, Cummins, and Tennyson (1992), and Cummins and Danzon (1995). Price is defined as the ratio of premiums written net of underwriting expenses and policyholder dividends to the discounted value of losses and loss adjustment expenses incurred. Thus, a price of one means that for every dollar of premium collected, one dollar (in present value terms) of loss-related costs are paid out. The payout patterns of losses are estimated based on industry-wide payout tails. Payout tails for Schedule P lines are estimated by line. Payout tails for all other lines are based on aggregate Schedule O data. Yield curves were obtained from the U.S. Treasury yield curves presented in Coleman, Fisher, and Ibbotson (1989). See Cummins and Danzon (1995) for a more complete description of the present value methodology.

The primary implication of the option pricing model for insurance is that the price of insurance should be positively related to the safety of the firm. Simply put, insureds are willing to pay a higher premium to one company than to another for the same insurance if the former company is less likely to become insolvent than the latter. As demonstrated earlier, the level of insurer safety depends jointly on the capitalization of the firm and the level of risk in the firm's asset-liability portfolio, since these two factors determine the value of the firm's insolvency put option. Therefore, the two key explanatory variables in the price equation are measures of firm capitalization and portfolio volatility. Lagged values of these measures are used in the equation, since it is their values at the beginning of the period that are most likely to impact the prices obtained during the period.

Firm capitalization is measured as the capital-to-asset ratio of the company, defined as the ratio of adjusted statutory capital to total assets.[4] Statutory capital is adjusted to more accurately reflect GAAP capital.[5] This variable is designated as CAP.

The measure of portfolio risk used is that developed by Cummins and Sommer (1996). The risk parameter comes from the option model, that is, $\sigma^2 = \sigma_A^2 + \sigma_L^2 - 2\,\rho\,\sigma_A\,\sigma_L$. To quantify this variable, estimates are needed of the asset and liability volatilities and the correlation coefficient between the asset and liability processes. The asset and liability portfolios of each insurer are treated as separate, correlated mutual funds. Return data on assets were obtained as $r_{it} = \ln(I_{it}/I_{i,\,t-1})$, where I_{it} = total return index for asset category i in quarter t from Ibbotson Associates (1991). Accumulation rates on losses in various insurance lines were obtained similarly as $s_{jt} = \ln(L_{jt}/L_{j,\,t-1})$, where L_{jt} = losses and loss ad-

[4] The use of the capital-to-asset ratio is appropriate based on the option model, since the ratio is simply equal to $(1 - L/A)$.

[5] Specifically, capital is adjusted for prepaid acquisition cost by adding the product of the expense ratio and the unearned premium reserve to statutory surplus. Also, the reserve for unauthorized reinsurance and the excess of statutory over statement reserves are added to surplus. These are standard GAAP adjustments.

justment expenses incurred in line j and quarter t from the A. M. Best Company quarterly by-line data base.[6]

The asset and liability return series are used to create a quarterly return series for each of the NT observations in the sample, based on the asset and liability portfolio allocations for each insurer in each year. The insurer asset and liability mutual fund return series for insurer k in year y are obtained as

$$r_{Akyt} = \sum_{i=1}^{M} w_{kyi}\, r_{it} \quad \text{and} \quad s_{Lkyt} = \sum_{j=1}^{Q} x_{kyj}\, s_{jt}, \tag{4}$$

where w_{kyi} = the proportion of insurer k's asset portfolio invested in asset category i in year y,

x_{kyj} = the proportion of insurer k's loss and premium reserves in insurance line j in year y,

M = the number of asset categories, and

Q = the number of liability categories.

These calculations yield quarterly time series, r_{Akyt} and s_{Lkyt}, for insurer k in year y, where t = 1,..., 60 (a quarterly time series from 1975 through 1989). The standard deviations and correlation coefficient of these time series are used to calculate σ^2_{ky}, the overall portfolio risk parameter for insurer k in year y. The calculations are then repeated for the other years in the sample period using the insurer's portfolio weights appropriate for those years.[7] The result is an annual time series of σ^2_{ky} for each insurer in the sample. The square roots of these volatility parameters are used in the regression estimation and are labeled as SIGMA.

This overall measure of portfolio risk represents a significant improvement over the traditional risk measures used in the financial literature on property-liability insurance. The typical approach to controlling for portfolio risk is to include asset and liability portfolio proportions as regressors. For example, Harrington and Nelson (1986) use the proportion of assets in equities as a proxy for asset risk and the proportion of liabilities in various lines of insurance to proxy

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[6] The period over which returns were calculated, dictated by the availability of the A. M. Best quarterly loss data, was 1975 through 1989. The asset categories used were long-term government bonds, intermediate-term government bonds, U.S. Treasury bills, and U.S. common stocks. These assets represent 75 percent of property-liability insurer assets. Other asset categories were combined into the most appropriate of these categories. Mortgage loans were placed in the long-term bond category, real estate was placed in the common stock category, short-term receivables were placed in the T-bill category, and other assets were placed in the intermediate-term bond category. The liability categories used were fire, allied lines, homeowners and farmowners multiple peril, commercial multiple peril, inland marine, workers' compensation, medical malpractice, other liability, auto liability, auto physical damage, and all other lines.

[7] Thus, the weights vary by year but the entire time series on r_{it} and s_{jt} are used in calculating the volatility and correlation parameters for a given year y.

liability risk. The portfolio risk measure used here incorporates more complete information about the composition of the asset and liability portfolio and accounts for correlations among assets and liabilities. Thus, it is more consistent with financial theory than previous approaches.

In addition to capitalization and portfolio risk, other factors may also be anticipated to affect the price of property-liability insurance. One such factor is firm size. Larger firms would be expected to be more diversified than smaller firms, and therefore safer, implying higher prices for larger firms. If the measure of portfolio risk were perfect, any diversification due to size would be fully reflected in the SIGMA variable and it would not be expected that size would have any independent effect. However, the method used here for calculating SIGMA does not allow for asset and liability volatilities to vary by firm size, since it is only the proportions of various assets and liabilities that impact the measure. Thus, the equation to be estimated includes a size variable (SIZE) to capture any diversification effect missed by the SIGMA variable. The size variable is defined as the natural logarithm of total firm assets.

Some property-liability insurers are organized as single entities, whereas others are made up of a group of affiliated companies. Two variables are included to reflect these organizational differences, SINGLE and HERF. The SINGLE variable is a dummy variable which equals one if a firm operates as an unaffiliated single company, and zero otherwise. HERF is the intragroup Herfindahl index of the insurer group based on net premiums written. It is hypothesized that single firms will command higher prices than groups, and concentrated groups (i.e., those with higher HERF values) will command higher prices than groups where the business is widely disbursed among the group members. This expectation results from the fact that it is possible that a member of a group may become insolvent and not be bailed out by the rest of the group, even if the group as a whole is solvent. Thus, an insurer group may be viewed as a portfolio of options, whereas a single firm is an option on a portfolio. The portfolio of options is worth more to shareholders and less to policyholders than if the same total assets and liabilities were part of a single company.

Cummins and Sommer (1996) find that insurers tend to balance capital and portfolio risk, with higher risk being offset with higher capital. Because capital is costly, it is likely that prices for long-tail lines of insurance would be higher than prices for short-tail lines, since insurers will need to maintain higher capital levels to support the riskier long-tail lines.[8] Therefore, a variable is also included which is defined as the percentage of premiums written in long-tail lines. The variable is designated as LTAIL, and the expected coefficient is positive.

Regulation might have an impact on price in a couple of ways. If consumers perceive that stringent regulation is likely to result in increased safety of insurers,

[8] Note that the relationship between prices for short-tail and long-tail lines does not depend on the timing of cash flows, since the definition of price being used accounts for such timing through present value calculations.

they may be willing to pay a higher price for insurance from a firm that is more strictly regulated. Also, regulation may increase the cost of doing business and thus contribute to higher prices. The state of New York is generally recognized as having the most stringent insurance regulations in the United States. Therefore, as a proxy for the stringency of regulation of a company, a dummy variable called NYREG is included which equals one if the firm is licensed in New York and zero if it is not. The expected sign on this variable is positive for the reasons described above.

Another aspect of regulation is rate regulation. A large proportion of premiums written that are subject to rate regulation is likely to be associated with a lower value for PRICE, if regulation is holding down rates. Given available data, the proxy variable used to capture this effect is the proportion of premiums written in workers' compensation and auto liability, since these two lines are generally subject to the strictest rate regulation. The variable is designated as RATEREG.

Finally, three dummy variables are included primarily as control variables, without strong theoretical predictions on expected signs. The first of these dummy variables (NATIONAL) equals one if a firm is designated by A. M. Best as a national firm and zero otherwise. The second (AGENCY) equals one if the firm uses an independent agency marketing system and zero otherwise. The third (CHELD) equals one if a firm's stock is closely held and zero otherwise.

The final equation to be estimated, then, is as follows:

$$\begin{aligned} \text{PRICE}_{jt} = {} & \alpha_0 + \alpha_1\text{CAP}_{j,\,t-1} + \alpha_2\text{SIGMA}_{j,\,t-1} + \alpha_3\text{SIZE}_{j,\,t} + \alpha_4\,\text{SINGLE}_{j,\,t} \\ & + \alpha_5\text{HERF}_{j,\,t} + \alpha_6\text{LTAIL}_{j,\,t} + \alpha_7\text{NYREG}_{j,\,t} + \alpha_8\text{NATIONAL}_{j,\,t} \\ & + \alpha_9\text{AGENCY}_{j,\,t} + \alpha_{10}\text{CHELD}_{j,\,t} + \alpha_{11}\text{RATEREG}_{j,\,t} + \gamma_{jt}\,. \end{aligned} \tag{5}$$

The definitions and predicted signs of the variables in this equation are summarized in Table 1.

METHODOLOGY, SAMPLE SELECTION, AND RESULTS

For estimation purposes, the autoregressive two-stage least squares (A2SLS) method of Kmenta (1986) is used. This method is appropriate because the right-hand side of the PRICE equation contains the lagged values of CAP and SIGMA. As demonstrated by Cummins and Sommer (1996), capital and portfolio risk cannot be treated as independent of one another. Their results show a significant positive simultaneous relationship between these two factors. Because lagged values of CAP and SIGMA are used here, this would not be an issue if there was no autocorrelation in the data. However, not unexpectedly, tests reveal autocorrelation, and thus the variables cannot properly be treated as predetermined.

Thus, we have a system of three equations, one for PRICE and one each for the lagged values of CAP and SIGMA. The A2SLS procedure is designed to deal with the situation of simultaneous equations with lagged endogenous variables in the presence of autocorrelation. The procedure essentially treats lagged endogenous

Table 1
Definitions and Predicted Signs of Variables in the Price Estimation

Variable	Definition	Predicted Sign
CAP_{t-1}	Statutory capital with GAAP adjustments divided by total assets	+
$SIGMA_{t-1}$	Estimated portfolio standard deviation	–
SIZE	ln(Assets)	+
CHELD	1 for closely-held firms, 0 otherwise	?
NATIONAL	1 for national firms, 0 otherwise	?
SINGLE	1 for unaffiliated single companies, 0 for groups	+
HERF	A Herfindahl index based on net premiums written by the members of the insurer group	+
NYREG	1 if firm is licensed in New York, 0 if not	+
AGENCY	1 for independent agency firms, 0 otherwise	?
LTAIL	Percent of premiums written in Schedule P lines	+
RATEREG	Percent of premiums written in workers' compensation and auto liability	–

variables in the same manner as current endogenous variables (see Kmenta, 1986, for further details).

In order to perform the A2SLS procedure, the structural equations for the lagged values of CAP and SIGMA must be specified. To do this, Cummins and Sommer's (1996) method is used as a basis. In addition to the variables already discussed for the PRICE equation, these structural equations also include the current interest rate on intermediate-term government bonds, annual industrial production growth, and the changes in bond and stock volatilities. The results for these structural equations are not presented. See Cummins and Sommer (1996) for empirical analysis that focuses on the choice of capital ratios and portfolio risk in property-liability firms.

Annual data for the period 1979 through 1988 from the A. M. Best Company data tapes are used to estimate the price equation. Because changes in the statutory reporting of loss reserves make it difficult to compare price ratios after 1988 with those computed using earlier data, the sample could not extend past 1988. Only stock insurers with data available throughout the sample period are included in the sample.[9] The sample includes all insurer groups meeting the above criteria as well

[9] Mutual insurers raise their own unique set of questions. Under the option model, stockholders in a stock insurer hold a long position in the firm's insolvency put, whereas policyholders hold a short position in the same put. With a mutual insurer, policyholders hold both the long and short positions in the put, since they are owners as well as policyholders. Although this key difference in organizational form raises some intriguing issues, they are beyond the scope of this article.

as all unaffiliated single firms that had net premiums written from all lines of at least 0.0085 percent of total industry premiums in any of the years 1976, 1983, or 1990. This criterion was chosen judgmentally to eliminate extremely small firms.

A total of 144 firms met the above criteria, of which two were eliminated based on an analysis of residuals from preliminary regressions. Thus, the final sample includes 142 firms over a ten-year period, yielding a total of 1,420 observations. Summary statistics for the variables used in the analysis are presented in Table 2.

Table 2
Summary Statistics for All Variables Used in the Analysis, 1979 Through 1988

Variable	Mean	Standard Deviation
PRICE	1.155	0.354
Capital-to-Asset Ratio (CAP)	0.342	0.127
Portfolio Standard Deviation (SIGMA)	0.133	0.043
Ln(Assets) (SIZE)	18.982	2.027
Closely-Held (CHELD)	0.423	N.A.
National Firm (NATIONAL)	0.197	N.A.
Single Firm (SINGLE)	0.324	N.A.
Intragroup Herfindahl (HERF)	0.432	0.375
New York Licensed (NYREG)	0.613	N.A.
Independent Agency Firm (AGENCY)	0.803	N.A.
Percent Long Tail (LTAIL)	0.603	0.267
Price Regulation (RATEREG)	0.348	0.246
Number of Observations (142 firms for ten years)	1,420	

Note: PRICE = premiums written, net of expenses and policyholder dividends, divided by the present value of losses incurred. All other variables are defined in Table 1. All insurance company data are from A. M. Best.

The regression results for the PRICE equation appear in Table 3. The two most important variables in the equation are those that directly determine the insolvency risk of the firm; namely, the lagged values of the capital ratio and portfolio risk. As predicted, the coefficient on the capital ratio variable (CAP (t − 1)) is significantly positive, and the coefficient on the portfolio risk measure (SIGMA (t − 1)) is significantly negative. These results support the hypothesis that safer firms command higher prices.

Table 3
Estimation Results: Dependent Variable = PRICE

Variable	Coefficient	t-statistic
Intercept	3.037	−4.463
Capital-to-Asset Ratio (CAP_{t-1})	3.188	7.264
Portfolio Standard Deviation ($SIGMA_{t-1}$)	−3.213	−2.449
Ln(Assets) (SIZE)	0.147	4.958
Closely-Held (CHELD)	0.229	2.660
National Firm (NATIONAL)	−0.132	−1.096
Single Firm (SINGLE)	0.580	4.393
Intragroup Herfindahl (HERF)	0.240	2.063
New York Licensed (NYREG)	0.023	0.272
Independent Agency Firm (AGENCY)	0.046	0.508
Percent Long Tail (LTAIL)	0.612	5.400
Price Regulation (RATEREG)	−0.420	−2.876
R^2	0.516	

Note: Variables are defined in Table 1.

The coefficient on the firm size variable is positive and significant. This is what was predicted if larger firms are safer than otherwise equivalent smaller firms due to diversification effects not captured by the measure of portfolio risk. Of course, there could be other explanations for why larger firms command higher prices, such as market power or name recognition by consumers.

The variables related to single and group organizational structure both have positive and significant coefficients. These results support the "portfolio of options" concept described earlier, which implies that a policyholder is better off with a policy from a firm organized as a single company than with one from a member of an insurer group when the single company and group are otherwise identical.

As predicted, the coefficient on the proportion of insurance written in long-tailed lines is significantly positive. Thus, firms appear to charge higher prices for risky long-tailed insurance than for safer short-tailed insurance. This is as expected if firms balance capital and portfolio risk, as found by Cummins and Sommer (1996), and thus must hold greater costly capital to support riskier lines of insurance.

The coefficient on the New York regulatory variable, while positive as predicted, is not significant. Thus, no evidence is found that stricter solvency regulation alone leads to higher prices either due to consumer confidence in heavily regulated insurers or the imposition of regulatory costs. This does not, of course, imply that solvency regulation is irrelevant. Regulation may lead to higher capitalization and lower portfolio risk, which are measured separately and are significant. The results merely imply that given capitalization and risk, the existence of stringent regulation may not lead to higher prices. It is also possible that New York licensing is simply an inadequate proxy for regulatory stringency.

The rate regulation variable has a negative and significant coefficient. This is consistent with the argument that rate regulation keeps insurance prices lower than they otherwise would be.[10]

With regard to the remaining dummy variables, the national firm variable is negative but not significant, the closely-held firm variable is positive and significant, and the agency variable is totally not significant. A negative sign for the national firm variable supports the managerial discretion hypothesis of Mayers and Smith (1981). Since national firms tend to underwrite more large, unique risks, their managers require more discretion. Consumers may be wary that they will use this discretion in ways that will hurt current policyholders, and thus demand lower prices from national firms.

Agency theory might explain the result for the closely-held variable. Agency theory implies that risk-taking should be inversely related to the degree of separation of ownership from management. Lamm-Tennant and Starks (1993) present evidence of this relationship in their study of ownership structure and risk. For stock firms, the implication is that closely-held firms would be expected to take on more risk than widely-held firms. If this takes the form of writing riskier policies, then the coefficient on the closely-held variable would be expected to be positive, since riskier policies are charged higher prices. Note that this implies that the closely-held variable is capturing an insurance risk effect beyond just the proportion of business in risky lines, which is captured by the long-tail variable. For example, within a particular line, closely-held firms may tend to write riskier individual policies. Cummins and Sommer (1996) find support for the hypothesis that closely-held firms tend to take on more risk.

CONCLUSION

The above results support the hypothesis implied by the option model of the insurance firm that the insolvency risk of insurers is reflected in the prices they receive for their insurance. This has some important implications. First, it means that even without regulation, market discipline exists in insurance markets that is likely to restrain insurer risk-taking. Firms that choose to be thinly capitalized and/or take on high levels of portfolio risk do so at a cost, that cost being the lower prices their insurance will command.

The results also demonstrate that many insurance purchasers recognize that the existence of guaranty funds does not provide them with full protection. If guaranty fund protection was seen as complete, there would be no reason for pur-

[10] It should be noted that RATEREG and LTAIL are highly correlated. Thus, it is difficult to completely disentangle the effects of rate regulation and risk. However, the significance of the coefficients supports the hypotheses presented. If RATEREG is removed from the regression, LTAIL remains positive and significant, and the results for the remaining variables are also not meaningfully changed.

chasers to pay higher prices for insurance from safer firms. Since guaranty funds do provide some protection, it can be assumed that the influence of firm safety on prices would be even greater without guaranty funds.

Another implication also relates to guaranty funds. The results yield an argument against the current system of flat rate guaranty fund premiums. Currently, guaranty fund assessments are a percentage of premiums written by the insurers within a state. Cummins (1988) proposed changing from such flat rate premiums to risk-based premiums, which would charge riskier firms higher premiums. The argument is that flat rate premiums give insurers the incentive to exploit the guaranty funds by taking on risk, since the funds do not require firms to compensate the guaranty funds for risk with higher premiums. If it is the case, as found above, that riskier firms receive lower prices for their insurance, the problem is compounded. Not only do guaranty funds not receive a higher premium for a higher-risk firm, the funds actually receive lower premiums from a risky firm than from a safe firm that sells an identical book of business, since the risky firm takes in less in premium revenue. This yields the perverse outcome of reverse risk-based guaranty fund premiums, with risky firms being rewarded for their risk through lower guaranty fund premiums. The incentives being provided by the market would appear to be much more constructive than those being provided by the guaranty fund system. This could be remedied with a system of risk-based guaranty fund premiums. Insurers would then bear the full impact of increased risk, through lower premiums received from purchasers and higher premiums charged by the guaranty funds. Methodologies have been developed for deriving the appropriate risk-based guaranty fund premiums (see Cummins, 1988).

Finally, the findings of this article have implications for the use and development of financial pricing models. Evidence of the existence of an empirical relation between insolvency risk and insurance prices illustrates the importance of incorporating default risk in financial pricing models of insurance.

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