Solvency regulation in the property-liability insurance industry: empirical evidence

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This article reports empirical evidence concerning the effects of solvency regulation on the number of companies and frequency of insolvencies. Minimum capital requirements appear to reduce insolvencies by reducing the number of small, domestic firms. This supports the view of capital requirements as a differentially higher tax on small, new firms. Other forms of regulation have ambiguous effects or none. A comparison of the characteristics of insolvent and solvent firms supports the model of insolvency as the (unlucky) outcome of value-maximizing risk-taking.

1. Introduction

■ The objective of this paper is to provide empirical evidence on the effects of solvency regulation of the property and liability insurance industry.[1] Elsewhere, we have developed a theoretical analysis of the insolvency problem and the effects of regulation (Smallwood and Munch, 1979) and discussed in detail the various forms of regulation (Munch and Smallwood, 1979). Our basic premise is that managers adopt those underwriting and investment risks that maximize the value of the firm. Thus, in contrast to previous studies of solvency regulation, we assume that the firm's probability of insolvency is chosen, not determined exogenously by the properties of the distribution of claims and investment returns. Solvency regulation is predicted to be effective only to the extent it modifies the incentives and constraints faced by the firm.

The rationale for solvency regulation is to protect the interests of policyholders, third-party liability claimants and other firms (to whom the obligations of an insolvent firm are shifted by guaranty fund arrangements). The public

[1] Property and liability insurance may be roughly defined as all lines other than life, accident, and health. It includes both commercial and personal lines and both third-party (liability) and first-party coverages. Total premium volume in 1977 was $71.7 billion, of which private passenger automobile accounted for over one-third. (*Best's Review, Property-Casualty Insurance Edition*, August 1978). There are over 2,000 firms in the industry. In 1945 the McCarran-Ferguson Act granted the insurance industry immunity from federal antitrust law, provided there is regulation at the state level. Subsequently, all states have enacted regulations relating to rates and to financial condition. Previous empirical studies of the effects of regulation have focused on rate regulation (Joskow, 1973; Ippolito, 1979). Studies of solvency regulation have been primarily prescriptive (Hofflander, 1969; Hammond, 1978).

good aspects of monitoring provide a *prima facie* case for regulation by a single authority. However, questions of feasibility and cost cast doubt on the overall efficiency of regulation in practice. Despite extensive regulation, many aspects of risk-taking necessarily remain uncontrolled, and it is an empirical question whether regulation in fact significantly reduces the frequency of insolvencies.

Against any potential benefits of regulation must be weighed the costs. The administrative costs are obvious.[2] Less evident are the adverse consequences arising from the fact that regulation raises the cost of entry and the minimum efficient scale of operation in the authorized section of the market. This imposes a loss on consumers if small firms provide a specialized and/or lower cost product than larger firms, and if the threat of entry by small firms constitutes an important competitive threat to established firms.[3]

Many of the 2,000 firms in the industry are small, are often organized as mutuals, and write a specific type of coverage for a carefully selected group of policyholders. The fact that such firms survive, when not subjected to a cost disadvantage by regulation, suggests that their apparent disadvantage in terms of diversification of risk is offset by a comparative advantage in selecting and monitoring policyholders. That there should be some advantages of small scale is not surprising in view of the inherent heterogeneity of policyholders and hence the importance of policyholder-specific information in accurately pricing the insurance product. Because the price of the insurance product is set before the cost is known and that cost is influenced by policyholder behavior, accurate information about expected claims cost and monitoring of moral hazard are crucial for successful writing.[4]

With the available data we cannot undertake a full weighing of the costs and benefits of solvency regulation. Our more limited objective is to demonstrate the effects of solvency regulation on the frequency of insolvencies and the number and average size of firms. The evidence presented in Section 2 suggests that minimum capital requirements do reduce the number of insolvencies, but that this is achieved solely by deterring the entry of small, relatively risky firms. We find no effect on the frequency of insolvencies among firms which do enter the market. Thus, the overall evaluation of solvency regulation reduces to the question of whether the net value to consumers of the type of firm that is eliminated is positive and exceeds the administrative cost of regulation.

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[2] In New York in 1974 regulation of financial condition absorbed over 50 percent of insurance department expenditure (*Regulation of Financial Conditions of Insurance Companies*, New York, 1974).

[3] Since 1975, at least 15 physician-owned mutuals have been formed to write medical mal practice. Other physicians and hospitals have chosen to form captive offshore companies, in part to avoid the regulations on the authorized market.

[4] Furthermore, it would be a mistake to conclude from the large total number of firms in the property-liability insurance industry that potential entry, and hence barriers to entry, are irrelevant to market performance. The industry consists of many submarkets, arising naturally from differences in types of coverage, policyholder characteristics, and, in liability lines, local legal environment. The information necessary to write specific coverages creates inevitable obstacles to the movement of firms among submarkets. Licensure requirements by line and by state impose an additional restriction on entry. At any one time there may be only two or three firms writing a specific line in a particular state. This is particularly true for the small liability lines, such as professional and municipal liability.

In Section 3 we compare the characteristics of a sample of insolvent firms with a matched sample of solvent firms. This evidence supports the theoretical predictions as to the characteristics likely to be associated with a relatively high preferred risk of insolvency.

2. Evidence on the effects of solvency regulation

■ The major forms of solvency regulation include minimum capital and surplus requirements, constraints on portfolio choice, the filing of detailed annual statements and triennial examinations. Preserving solvency is one of the stated objectives of rate regulation. In addition, most states have established a guaranty fund, which effectively transfers the obligations of an insolvent firm to other firms in the state.

We have argued elsewhere (Munch and Smallwood, 1979) that some forms of solvency regulation may operate as a differentially higher tax on small, new firms and hence tend to reduce entry to the authorized insurance market, increase minimum efficient firm size, and decrease the number of firms in a market.[5] On the other hand, these regulations (and also guaranty funds) may deter insolvencies, both by eliminating from the market firms which have a higher propensity to go insolvent and by raising the cost of risk taking for firms that do enter. In addition, rate regulation is expected to increase the number and to reduce the average size of firms, but possibly to increase profit margins. Its effect on frequency of insolvencies is uncertain *a priori*.[6] Guaranty funds transfer the incentive to monitor financial conditions from policyholders to other firms. Guaranty funds are therefore expected to decrease the frequency of insolvencies, if other firms are lower cost monitors of financial condition and report imminent insolvencies early enough to forestall them.

In this section we first test the hypothesis that solvency regulation reduces the number of firms and increases minimum efficient size. Because regulation is directed primarily at domestic firms, i.e., firms incorporated or domiciled in the state, we test for differential effects between domestic and nondomestic

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[5] Minimum capital regulation is likely to impose a binding constraint primarily on small, new firms for several reasons. First, for a given supply price of capital, the optimal level of capital is an increasing function of the number of policyholders and an increasing function of the age of the firm's "intangible capital," presumed to be a nondecreasing function of the age of the firm. Thus, the requirement to hold a specified absolute amount of capital (rather than some proportion of premium volume) is more likely to exceed the desired level for small, new firms.

Second, the supply price of the required amount of capital will be higher for new firms, if confidence in the investment expertise and honesty of management can only be established with experience. The requirement that some absolute amount of capital be held in specific securities is more likely to be a binding constraint on portfolio choice, the smaller the portfolio. Constrained, nonoptimal portfolio choice implies a higher supply price of capital. To the extent that fiduciary risk and constraint on portfolio selection raise the supply price of capital to small, new firms, their desired level of capital is reduced. This increases the likelihood that regulatory constraints will be binding. Binding regulatory constraints on small firms will tend to increase the minimum efficient size of the firm and reduce the number of firms in a market of given size.

[6] It has been argued (Joskow, 1973; Ippolito, 1979) that prior approval rate regulation facilitates cartel pricing by the insurance industry, limits expansion of more efficient firms, and protects small, less efficient firms. To the extent prior approval increases profit margins, it should reduce the frequency of insolvencies. On the other hand, this may be offset to the extent it tends to increase the proportion of small, relatively inefficient firms which are more prone to insolvency.

firms. Second, we test the hypothesis that regulation deters insolvencies and, if it does, whether this results solely from preventing firms which would accept a higher risk of insolvency from entering the market, or whether there is an additional deterrent effect on firms that do enter.

These hypotheses may be stated in terms of the following simultaneous system:

$$C = \alpha_0 + \alpha_1 TPRM + \alpha_2 R + u_1 \tag{1}$$

$$I = \gamma_0 + \gamma_1 C + \gamma_2 R + \gamma_3 X + u_2, \tag{2}$$

where

C = number of companies,
I = number of insolvencies,
$TPRM$ = total premiums (proxy for market size),
R = vector of measures of regulation,
X = vector of measures of underwriting experience,
$u_1 \sim N(0,\sigma_1)$,
$u_2 \sim N(0,\sigma_2)$,
$E(u_1,u_2) \neq 0$.

In estimating the effect of regulation on insolvencies, we control for average underwriting experience.[7] Given the variability of the claims distribution, the probability of insolvency is expected to be inversely related to the average margin between premium level and claims cost. Given the mean underwriting margin, the probability of insolvency is expected to be positively related to the variability of claims, particularly if year-to-year deviations from the mean are positively correlated.[8]

□ **The data.** Since regulation is state specific, the state is the basic unit of observation.

Number of companies and number of insolvencies. The data on the number of companies and insolvencies are from two sources: state insurance departments and *Best's Reports*. Unfortunately, *Best's* data exclude an unknown number of small companies, which are precisely those expected to be most affected by solvency regulation. We use three samples of companies. The first two, domestic companies only and total companies, i.e., domestic and licensed nondomestic companies for 1967 are from insurance department sources and include stocks, mutuals, and other types. The third sample is from *Best's* and is confined to stock companies active during the period 1957–1968. The three insolvency samples consist of two from insurance department sources for the periods 1958–1968 and 1965–1975. The third insolvency sample is confined to stock companies reported in *Best's*, 1957–1968.

Capital requirements. Because capital requirements vary by line of insurance, ownership type, state of domicile, years of operation, etc., any simple definition

[7] In principle, underwriting experience may itself be endogenous, depending in part on regulation. However, in regressions not reported here, we found no effect of regulation on the mean loss ratio.

[8] If the objective of insurance commissioners is to detect *relatively* risky companies, they may adjust downwards their standards of technical insolvency in years when underwriting results are bad for the industry as a whole. This will mitigate the expected increase in the number of insolvencies in years of generally bad underwriting results.

of capital requirements is necessarily arbitrary and entails measurement error. We consider six measures: the capital plus surplus requirements for writing a single line (casualty where available, automobile otherwise) and for multiple lines for each of three types of company, domestic stocks, domestic mutuals, and foreign mutuals.[9] The capital requirements for multiple lines are shown in Table 1.

Investments, examinations, etc. As a proxy for regulatory effort at enforcing all other forms of regulation, we use total expenditure of the insurance department, normalized on the total premium volume of the state.

Rate regulation. A binary variable indicates having some form of prior approval regulation as of September, 1973. This is a very imperfect indicator of the stringency of rate regulation. It obscures diversity among states classified as prior approval. Worse, it ignores differences in the timing of the switch to open competition. Sixteen of the 17 states classified as open competition switched from prior approval between 1960 and 1973, i.e., after the period of observation for most of our data. Thus, for the samples that predate the changeover, this variable is intended as a possible indicator of a regulatory environment that was tending toward competition, although nominally prior approval.

Guaranty funds. Since guaranty funds were introduced in most states at different times during the period spanned by the second insolvency sample, 1965–1975, the variable used is the number of years of operation of a guaranty fund prior to 1976.

Subrogation rights under the uninsured motorist provision. Many states have extended the uninsured motorist coverage (*UM*) to cases where the liable party's insurer becomes insolvent. This affects the incentives of shareholders and creditors to monitor solvency. Specifically, it reduces the number claimants against an insolvent insurer and hence reduces the expected costs of insolvency to shareholders and other creditors, *unless* the victim's insurer has subrogation rights against the insolvent insurer. Assuming that an insurance company is more likely to pursue its subrogation rights than is an individual claimant to pursue a liability claim, the incentives of the owners of a firm to avoid insolvency are higher in states in which insolvency is covered by *UM* coverage *and* the victim's insurer has subrogation rights against the insolvent insurer.

A binary variable takes the value of 1 if insolvency is covered by *UM and* the victim's insurer has subrogation rights against the insolvent insurer.

Underwriting experience. Our measure of the average underwriting profit margin is the average over the period 1966–1974 of the statewide average loss ratio, over all companies, for automobile liability insurance, as reported in *Best's*.[10] Among alternative measures of variability, the best fit was obtained with the maximum of a three-year moving average of annual loss ratios. Other

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[9] Requirements are always the same for domestic and foreign stocks.

[10] For the years 1966–1970 the series is for auto bodily injury, for 1971–1974 it is for auto liability. The mean loss ratio varies from 55 percent to 75 percent.

The loss ratio is losses incurred relative to premium earned, excluding loss adjustment expense, but adjusted for dividends to policyholders. To the extent low expenditure on claims is the result of high expenditure on claims defense, losses and loss adjustment are inversely correlated and the loss ratio is an imperfect measure of profit margin.

TABLE 1

NUMBER OF COMPANIES AND INSOLVENCIES, AND MULTIPLE LINE CAPITAL REQUIREMENTS

	COMPANIES			INSOLVENCIES			CAPITAL REQUIREMENTS	
	TOTAL, STOCK AND MUTUAL, 1967	DOMESTIC, STOCK, AND MUTUAL, 1967	DOMESTIC, STOCK, 1958–67	STOCK, MUTUAL 1967–75	STOCK, 1958–67	STOCK AND MUTUAL 1958–68	MUTUAL	STOCK
ALABAMA	894	106	18	2	0	0	1,000	1,000
ALASKA	448	5	1	0	0	0	400	600
ARIZONA	1,115	267	3	2	0	0	350	525
ARKANSAS	993	114	20	10	12	6	500	1,000
CALIFORNIA	895	149	89	8	2	3	1,000	2,000
COLORADO	841	54	17	4	2	2	750	750
DELAWARE	644	47	9	1	2	2	500	750
D.C.	712	31	12	1	1	0	150	300
FLORIDA	961	54	21	5	3	3	750	1,250
GEORGIA	911	68	17	2	1	0	400	600
HAWAII	415	16	7	0	0	0	500	750
IDAHO	740	26	2	0	1	0	1,300	1,300
ILLINOIS	1,323	472	93	16	8	17	1,000	1,500
INDIANA	1,125	183	31	2	3	6	1,000	1,000
IOWA	1,033	237	17	1	0	0	300	500
KANSAS	811	66	13	0	0	0	300	1,000
KENTUCKY	782	60	9	0	0	0	900	1,500
LOUISIANA	1,025	171	10	2	3	2	1,000	1,000
MAINE	666	42	5	3	1	1	1,000	2,000
MARYLAND	789	50	19	4	2	3	250	1,250
MASSACHUSETTS	524	63	25	3	1	1	1,000	1,000
MICHIGAN	916	96	19	2	3	3	1,000	1,500
MINNESOTA	773	230	20	2	2	1	500	1,000
MISSISSIPPI	990	231	3	0	0	0	300	1,000
MISSOURI	918	135	25	10	0	8	800	800
MONTANA	707	8	4	1	0	0	600	800
NEBRASKA	824	115	21	3	2	2	400	600
NEVADA	836	4	1	1	1	1	400	600
NEW HAMPSHIRE	550	27	10	1	0	1	100	1,200
NEW JERSEY	770	66	18	3	0	0	1,350	3,000
NEW MEXICO	831	13	1	0	0	0	600	600
NEW YORK	724	305	173	8	1	1	6,650	3,975
N. CAROLINA	693	74	16	0	0	0	700	1,800
N. DAKOTA	636	55	1	0	0	0	1,000	1,000
OHIO	1,023	217	38	4	1	0	200	1,000
OKLAHOMA	1,084	99	26	1	0	0	250	375
OREGON	802	34	5	0	0	0	500	1,000
PENNSYLVANIA	1,130	372	50	27	2	14	310	1,725
RHODE ISLAND	580	27	7	1	0	0	450	450
S. CAROLINA	733	64	29	1	4	1	305	500
S. DAKOTA	705	71	3	0	1	1	300	800
TENNESSEE	895	76	15	1	1	2	950	1,425
TEXAS	1,605	776	93	28	5	4	300	300
UTAH	785	24	1	0	0	0	550	1,000
VERMONT	813	18	4	0	0	0	250	400
VIRGINIA	880	91	5	0	0	0	800	800
WASHINGTON	850	42	9	0	0	0	1,300	1,300
W. VIRGINIA	781	40	8	2	3	3	1,125	1,125
WISCONSIN	933	264	25	1	0	2	100	2,925
WYOMING	701	9	0	0	0	0	300	600

TABLE 2

DEFINITION OF VARIABLES, SOURCES, MEANS AND STANDARD DEVIATIONS

VARIABLE	DEFINITION AND SOURCE	MEAN	STANDARD DEVIATION
DOMESTIC, STOCK AND MUTUAL COMPANIES, 1967	HART HEARINGS	117.4	139.4
TOTAL, STOCK AND MUTUAL COMPANIES, 1967	HART HEARINGS	842.3	210.4
DOMESTIC STOCK COMPANIES 1958–67	BEST'S INSURANCE REPORTS REPORTED IN NELSON	21.4	30.7
STOCK AND MUTUAL INSOLVENCIES 1967–75	NATIONAL ASSOCIATION OF INSURANCE COMMISSIONERS	3.3	5.9
STOCK AND MUTUAL INSOLVENCIES 1958–68	HART HEARINGS	1.8	3.4
STOCK INSOLVENCIES 1958–67	BEST'S INSURANCE REPORTS REPORTED IN NELSON	1.4	2.2
TOTAL PREMIUM 1967 ($0,000)	INSURANCE INDUSTRY COMMITTEE OF OHIO HART HEARINGS	106,231	139,248
FUNDS/PREMIUM	OPERATING EXPENDITURE OF INSURANCE DEPT. ÷ TOTAL PREMIUM. HART	.00084	.00036
PRIOR APPROVAL	PRIOR APPROVAL RATE REGULATION, NAIC. 1973.	.74	.44
ML ($000)	MULTIPLE LINE CAPITAL REQUIREMENTS, NAII. 1968.	734.8	920.7
COMPANY SIZE. ($0,000)	PREMIUM WRITTEN BY DOMESTIC COMPANIES/ # DOMESTIC COMPANIES. 1967. HART.	248.2	374.1
UM X SUBROGATION	UNINSURED MOTORIST COVERS INSOLVENCY AND SUBROGATION RIGHTS AGAINST INSOLVENT INSURER, MAGNUSON.	.5	.505
GUARANTY FUND	# YEARS OPERATION OF GUARANTY FUND. NCIGF	4.1	1.9
MAXIMUM LOSS RATIO	MAXIMUM 3–YEAR MOVING AVERAGE AUTO LOSS RATIO. BEST'S. 1966–74	65.7	6.5
MEAN LOSS RATIO	MEAN AUTO LOSS RATIO. BEST'S. 1966–74	62.0	4.8

measures tried were the average absolute deviation around the mean, the variance, and the third moment.

Market size. In estimating the effect of regulation on the number of firms, we control for the potential size of the market by including total premium volume written in the state in 1967. A more complete analysis would treat premium volume as endogenous. Potential simultaneous equations bias is discussed below.

Table 2 gives a summary of variables, sources, means and standard deviations.

□ **Regression results.** *Number of companies.* The first hypothesis to be tested is that solvency regulation creates diseconomies of small size and therefore decreases the number of firms operating in a state. To test whether regulations are more readily enforced against companies domiciled in a state, separate equations are estimated for domestic companies only and for total companies in the 1967 sample. The results are reported in Table 3. To allow for a nonlinear

TABLE 3

NUMBER OF COMPANIES, BY STATE OF DOMICILE, VARIOUS CLASSES, VARIOUS YEARS

	DOMESTIC, STOCK & MUTUAL, 1967[a]				TOTAL, STOCK & MUTUAL, 1967[a]				DOMESTIC, STOCK, 1958–67[b]			
	# COS		LOG_e# COS		# COS		LOG_e# COS		# COS		LOG_e# COS	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
TOTAL PREMIUM	1.301	.001** (5.56)			1.25	.002** (4.90)			.880	.2D–03** (8.26)		
(TOTAL PREMIUM)^2	–1.004	–.2D–08** (–2.84)			–1.116	–.4D–08** (–2.89)			.081	.041 (.67)		
FUNDS/ PREMIUM	.013	5015 (.11)	–.199	–626 (–2.15)	–.029	–16770 (–.23)	–.044	–30.31 (–.35)	.036	3065 (.669)	.002	8.14 (.03)
PRIOR APPROVAL	–.003	–1.057 (–.03)	.130	.336 (1.49)	–.058	–27.407 (–.47)	–.090	–.05 (–.75)	.002	.164 (.04)	.097	.280 (1.26)
ML	–.752	–.114** (–2.59)			–.47	–.108 (–1.50)			–.295	–.013** (–2.84)		
(ML)^2	.93	.26D–04** (2.62)			.535	.2 D–04 (1.38)			.268	.36D–05** (2.35)		
LOG TOTAL PREMIUM			.771	.765** (7.95)			.608	.131** (4.54)			.919	1.017** (10.31)
LOG ML			–.187	–.288** (–2.05)			–.248	–.083** (–1.96)			–.133	–.304 (–1.52)
C	––	81.78 (1.43)		–2.092* (–1.68)		811.1** (8.61)		5.86** (15.7)	––	7.04 (1.07)	––	
R^2/ARSQ	.504	.435	.668	.638	.411	.329	.363	.307	.895	.878	.742	.719
SEE	104.7		.690		172.4		.207		10.73		.678	

(1) BETA COEFFICIENT.
(2) COEFFICIENT/t–RATIO IN PARENTHESES.

[a]ML = MULTIPLE LINE CAPITAL REQUIREMENT FOR MUTUAL COMPANIES.
[b]ML = MULTIPLE LINE CAPITAL REQUIREMENT FOR STOCK COMPANIES.
* = SIGNIFICANT AT 10% LEVEL, 2–TAILED TEST.
** = SIGNIFICANT AT 5% LEVEL, 2–TAILED TEST.

effect of market size and capital requirements, for each sample we report two specifications, one including squared terms, the other in log linear form.

In the first pair of equations reported in Table 3 (domestic companies, 1967) the negative coefficient on *ML*, the multiple line capital requirement, and positive coefficient on $(ML)^2$ support the hypothesis that capital requirements reduce the number of companies domiciled in a state, with the negative effect diminishing at higher levels of capital requirements.[11] The magnitude of the effect is calculated in Table 4, which shows the change in the number of domestic companies implied by the mean, minimum, and maximum observed *ML*, excluding New York. The minimum, $100,000, has essentially no effect; the mean of $735,000 implies a decrease of 84 domestic companies; the function reaches a maximum at $4,324,000, which eliminates 147 companies; for even higher requirements the predicted effect is positive, because the positive

[11] An *F*-test on the addition of the two capital requirement variables to the estimating equation indicates significance at the .01 percent level.

TABLE 4

PREDICTED EFFECT OF CAPITAL REQUIREMENTS ON NUMBER OF DOMESTIC COMPANIES

SAMPLE	CAPITAL REQUIREMENTS ($000)					
	MUTUAL			STOCK		
	MIN(100)	MEAN(735)	MAX[1](1350)	MIN(300)	MEAN(1103)	MAX[1](2000)
DOMESTIC COMPANIES, STOCK & MUTUAL, 1967	−1	−84	−140	0	−118	−174
TOTAL COMPANIES, STOCK & MUTUAL, 1967	−1	−79	−133			
DOMESTIC COMPANIES STOCK, 1958–67				0	−14	−20

[1]EXCLUDING NEW YORK.

squared term dominates the negative linear term.[12] As can be seen in Table 2 which reports the actual capital requirements by state, all states except New York have requirements of $2,350,000 or less, and thus fall well within the range of negative impact.[13]

Since the minimum, mean, and maximum number of companies in the sample are 4, 117, and 776, respectively, these estimates of the magnitude of the effect of capital requirements seem reasonable. The log linear specification supports the conclusion that the effect of capital requirements on number of domestic companies is negative and nonlinear. The estimated elasticity is −.288.

The next hypothesis is that capital requirements only affect a firm's decision whether to incorporate in a state, not whether to obtain a license to operate in the state. If capital requirements are unenforceable against nondomestic companies, high capital requirements will merely induce the substitution of foreign for domestic incorporation, with no effect on the total number of (licensed) companies.

The second set of equations in Table 3 provides weak evidence against the substitution hypothesis. The coefficients on ML and $(ML)^2$ are similar to the corresponding coefficients in the equation for domestic companies only, but the t-statistics are not significant at the 10-percent level.[14] The implied effect on the total number of companies is similar to that for domestic companies: −2 at the minimum, −80 at the mean, and −133 at the maximum, excluding New York.[15] Thus the reduction in total companies is essentially the same as the reduction in domestic companies. This suggests that the capital requirements are

[12] Since $(ML)^2$ is measured in deviations from the mean, the net effect of capital requirements at the point of means is given by the coefficient on ML alone.

[13] At $6,650,000, New York is 6 standard deviations above the mean. Similar results were obtained using the capital requirement for stock companies, for which the range is smaller ($300,000–$3,975,000) and for which New York is only 4 standard deviations above the mean. The implied effects range from essentially zero at the minimum of $300,000 to −118 companies at the mean of $1,103,000 and reach −174 at $2,000,000, with the maximum excluding New York.

[14] The addition to the adjusted R^2 from adding the vector of capital requirement variables is not significant at the 10-percent level.

[15] Because the number of total companies typically exceeds the number of domestic companies, elasticities and beta coefficients are larger for domestic than for total companies.

indeed effective only against domestic companies. However, foreign companies do not replace the domestic companies that are eliminated by high entry requirements. A plausible explanation of this absence of substitution is that the type of company which is eliminated by high capital requirements is a small company offering a specialized product which is not readily exported, such as a highly selective mutual. A small firm must offset its comparative disadvantage at diversification by superior efficiency in selecting low risks and providing incentives for loss prevention, i.e., reducing the dead weight loss due to moral hazard and hence the loading charge.[16]

The third sample in Table 3 is domestic stock companies active over the period 1958–1967. The effect of *ML* is again negative, but nonlinear.[17] The implied reduction in number of domestic stock companies increases from zero at the minimum of $300,000 to a maximum effect of −20 companies at $2,136,000. The great majority of states fall in the range for which the net effect is an increasing function of requirements.[18] The evidence from this sample confirms that the effect of capital requirements is not confined to mutual companies nor to companies too small to be listed in *Best's*. However, the beta coefficients are smaller for this sample than for the other two samples which include mutuals and many smaller companies. This implies that capital requirements explain less of the across-state variance in the number of larger, stock companies than in the total number of companies, including mutuals and small companies.[19]

Turning to the other variables, we find that the beta coefficients indicate

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[16] The following table shows the number of fire and casualty companies, by type and place of domicile for Ohio in 1976:

	domestic	foreign	alien	total
stock	45	327	15	387
mutual	24	79	—	104
reciprocal	3	13	—	16
assessment fire	69	—	—	69.

The difference between the distribution by type of domestic and nondomestic firms is striking. Assessment fire companies are the largest single category of domestic firms, but there are no nondomestic firms of this type (*source*: State of Ohio, Department of Insurance, 110th Annual Report).

[17] For this sample, *ML* is the multiple line requirement for stock companies.

[18] An *F*-test on the addition of the vector of capital requirements variables shows significance at the 5-percent level.

[19] We tested the hypothesis that the effects of capital requirements increase with the degree of constraint on the type of asset that may be held and on the enforceability of the requirements. For both reasons, security deposits, minimum capital for stock firms and surplus for mutuals, surplus required at licensure, and finally operating surplus for stock companies are expected to be of decreasing degree of stringency. The results for the domestic companies' 1967 sample were weakly in support of the theory, with minimum capital and entry surplus having a larger and more significantly negative effect on the number of companies than operating surplus. For the other samples, however, separate effects of the different requirements were not distinguishable. Other specifications of capital requirements were considered, but provided a worse fit to the data than those reported in Table 3.

The single line requirement, for either stocks or mutuals, was insignificant when added after the multiple line requirement, and had less explanatory power when included alone. Similarly, including both stock and mutual requirements added no explanatory power. The ratio of the single to the multiple line requirement and the requirement for nondomestic mutual companies were insignificant.

that the variable contributing most to variation in the number of companies is premium volume, an imperfect measure of the size of the market.[20]

Of the other regulatory variables, insurance department operating expenditure relative to premium volume is insignificant in all equations except for the log-linear specification for domestic companies in 1967, where it is significantly negative. The theoretical prediction is that if department expenditure operates simply as a tax per premium dollar, it should have no effect on the number of companies, given premium volume.[21] If, on the other hand, examinations, etc., impose a proportionally larger tax on smaller firms because of fixed costs, a negative relation between the number of firms and the department expenditure is predicted. Because each insurance department is responsible primarily for its domestic firms, the negative effect is expected to be stronger on domestic than on total firms. This prediction is supported only by the log-linear specification for the sample that includes small firms.

Prior approval rate regulation has no consistent, significant effect on the number of companies. This is at best weak evidence against the hypothesis that prior approval tends to protect small firms, because our binary variable is an imperfect index of the stringency of rate regulations in 1967.[22]

In conclusion, the evidence seems clear that capital requirements reduce the number of firms writing insurance in a state. The impact falls almost exclusively on domestic companies.[23] With the available data we cannot determine whether this uneven incidence results because regulations are unenforceable against nondomestic companies or because the capital requirements are only binding on small firms and multistate firms typically exceed the critical size.

The elimination of small firms may impose costs on consumers in two ways. First, the range of "quality" of product available may be reduced if small firms provide specialized forms of coverage tailored to the needs of relatively

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[20] Strictly, premium volume should be treated as an endogenous variable in the system:

$$\Pi = a_0 + a_1 N + a_2 R + a_3 X + e_1 \quad \text{(i)}$$

$$N = b_0 + b_1 \Pi + b_2 R + b_c Y + e_2, \quad \text{(ii)}$$

where

Π = total premium volume,
N = number of firms,
R = vector of regulatory variables,
X, Y = vectors of other exogenous variables, and
e_1, e_2 = error terms.

If equation (ii) is estimated by using the observed value of Π, the coefficients are unbiased provided both $a_1 = 0$, and u_1 and u_2 are uncorrelated, i.e., premium volume is independent of the number of firms in the market.

[21] In terms of supply and demand for dollars of coverage, the tax implies a vertical shift in the supply schedule which may increase or decrease premium volume, depending on the elasticity of demand. However, the tax has no effect on minimum efficient firm size.

[22] Other studies have reported findings that prior approval regulation tends to decrease the market share of the direct writers (Joskow, 1973; Ippolito, 1979). Thus, to the extent our prior approval variable does reflect differences in the regulatory environment in 1967, the finding of no effect on the number of firms suggests that prior approval tends to increase the average size of bureau firms, rather than permit the proliferation of more small firms.

[23] In regressions reported elsewhere (Munch and Smallwood, 1979), we estimate that capital requirements increase average firm size and decrease the percentage of licensed companies domestically incorporated.

small groups of policyholders. Second, prices, at least to some consumers, may be higher, either because of the relatively low cost of the eliminated firms or because of the reduction in competitive pressure on remaining firms. We lack the data to measure these effects. We can only speculate that these costs will be greatest in lines which are relatively concentrated and where the formation of small companies is potentially cost-effective, as in fire, product liability, and medical malpractice.[24]

Number of insolvencies. Capital requirements have been shown to reduce the number of firms in the market, and hence potentially to impose costs on consumers. The next question is whether regulation conveys offsetting benefits by deterring insolvencies and, if it does, whether the effect results simply from having prevented firms which would accept a higher risk of insolvency from entering the market, or whether there is a further, "conditional" deterrent effect on firms that do enter.

The hypothesis that solvency regulation has a conditional deterrent effect is tested in three ways. The first involves estimation of a reduced form equation for the number of insolvencies. Combining equations (1) and (2) above, the reduced form for the number of insolvencies is:

$$I = \gamma_0 + \gamma_1[\alpha_0 + \alpha_1 TPRM + \beta_0 R + u_1] + \beta_1 R + u_2 \qquad (2a)$$
$$= \delta_0 + \delta_1 TPRM + \delta_2 R + \gamma_1 u_1 + u_2.$$

The hypothesis that capital requirements have a deterrent effect over and above the entry effect implies that $\beta_1 < 0$. We can solve for the structural parameters from the estimated coefficient as follows:

$$\hat{\gamma}_1 = \frac{\hat{\delta}_1}{\hat{\alpha}_1}; \qquad \hat{\beta}_1 = \hat{\delta}_2 - \hat{\gamma}_1 \hat{\beta}_0.$$

Table 5 reports regressions for three samples of insolvencies: stock and mutual companies, 1965–1975; stock and mutual companies, 1958–1968; and stock companies only, 1958–1967. The first equation for each sample is the OLS reduced form. The multiple line capital requirement has a significant negative effect on the number of insolvencies in the first two samples, but an insignificant negative effect in the third sample, which includes only firms large enough to be reported in *Best's*.

To solve for the structural parameters we use the 1967 domestic companies equations from Table 3 and the 1965–1975 stock and mutual insolvency equation from Table 5. The estimated coefficients yield the following estimates of the structural parameters of interest:

$$\hat{\gamma}_1 = \frac{.00004}{.001} = .04$$
$$\hat{\beta}_1 = -.003 + (.04 \times .114)$$
$$= .0016$$

[24] For example, although there are over 2,000 firms in the industry nationwide, it is not uncommon for there to be only two or three writers of medical malpractice in a state. Following the malpractice insurance "crisis" in 1975, which was characterized by premium increases of over 300 percent in some states and withdrawal of all commercial carriers in others, a sizeable number of physician-owned mutuals entered the authorized market. However, some physicians and hospitals resorted to the formation of captive, offshore companies, in part to avoid the regulatory requirements of the authorized market.

TABLE 5

NUMBER OF INSOLVENCIES, DOMESTIC COMPANIES; BY STATE OF DOMICILE

	STOCK & MUTUAL 1965–75[a]				STOCK & MUTUAL 1958–68[a]				STOCK 1958–67[b]			
	OLS		TSLS		OLS		TSLS		OLS		TSLS	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
TOTAL PREMIUM	.947	.4D–04** (6.44)			.664	.2D–04** (3.80)			.331	.5D–05* (1.67)		
COMPANY SIZE	–.170	–.003 (–1.41)	.203	.003** (2.19)	–.140	–.001 (–.98)	.122	.001 (.89)	–.085	–.5D–03 (–.49)	–.024	–.1D–03 (–.15)
FUNDS/ PREMIUM	.092	1492 (.917)	.086	1391 (1.02)	–.108	–993 (–.91)	–.111	–1023 (–.89)	.079	480 (.55)	.052	317 (.37)
PRIOR APPROVAL	–.055	–.73 (–.52)	–.117	–1.57 (–1.35)	–.182	–1.378 (–1.46)	–.225	–1.704* (–1.74)	–.070	–.351 (–.46)	–.082	–.409 (–.56)
UM X SUB– ROGATION	.344	4.03** (3.25)	.149	1.752* (1.60)	.420	2.789** (3.34)	.281	1.867** (2.02)	.380	1.661** (2.43)	.374	1.635** (2.45)
GUARANTY FUND	–.200	–.621* (–1.85)	–.158	–.490* (–1.72)	–.167	–.294 (–1.30)	–.136	–.239 (–.99)	–.112	–.129 (–.71)	–.114	–.132 (–.74)
ML	–.485	–.003** (–3.51)	–.005	–.3D–04 (–.06)	–.361	–.001** (–2.20)	–.026	–.9D–04 (–.19)	–.153	–.5D–03 (–.79)	–.096	–.3D–03 (–.53)
MAXIMUM LOSS RATIO	.662	.601** (2.09)	.803	.730** (3.03)	.583	.300 (1.55)	.681	.351* (1.73)	.142	.048 (.31)	.154	.052 (.34)
MEAN LOSS RATIO	–.527	–.651* (–1.64)	–.694	–.856** (–2.58)	–.398	–.279 (–1.04)	–.514	–.360 (–1.29)	.075	.034 (.16)	.064	.029 (.14)
#COMPANIES		––	.885	.038** (8.03)		––	.629	.015** (3.84)		––	.252	.018 (1.38)
C		2.61 (.26)		4.32 (.51)		.599 (.08)		1.236 (.17)		–4.29 (–.78)		–4.163 (–.77)
R^2/ARSQ	.6302	.5470	.749		.479	.362	.441		.2147	.0381	.266	
SEE	3.98		3.346		2.68		2.822		2.168		2.104	

(1) BETA COEFFICIENT.
(2) COEFFICIENT/t–RATIO.

[a]ML = MULTIPLE LINE CAPITAL REQUIREMENT FOR MUTUAL COMPANIES.
[b]ML = MULTIPLE LINE CAPITAL REQUIREMENT FOR STOCK COMPANIES.
* = SIGNIFICANT AT 10% LEVEL, 2–TAILED TEST.
** = SIGNIFICANT AT 5% LEVEL, 2–TAILED TEST.

This suggests that the negative coefficient on *ML* in the reduced form is attributable to the negative effect of capital requirements on the number of companies. By this test there is no evidence that capital requirements have an additional deterrent effect.

The same conclusion emerges from the second test, in which number of insolvencies is regressed on a predicted value of the number of companies, capital requirements, and other variables by using two stage least squares.[25] This is the second equation in each sample in Table 5. In all cases the coefficient on capital requirements is negative, but not statistically significant.

For the third test the insolvency rate, computed as the ratio of the number of insolvencies to the number of companies, was regressed on capital require-

[25] The number of companies is the number of domestic stock and mutual companies in 1967 for the first two samples and the number of domestic stock companies 1958–1967 for the third sample.

ments and other variables. The results are not reported because almost all variables, including capital requirements, were insignificant. Thus all three tests support the same conclusion—there is no evidence that capital requirements have an independent deterrent effect on the number of insolvencies over and above the effect on the number of companies.

The most important variable explaining number of insolvencies is market size, whether measured by the total premium volume or by the predicted number of domestic companies. Of the other regulatory variables, department expenditure has no significant effect. Prior approval regulation has a consistently negative effect, although the significance level is low by conventional standards.

The number of years in which the state has operated a guaranty fund has the predicted negative sign, significant at the 10-percent level, in the 1965–1975 sample of insolvencies. This is consistent with the hypothesis that other companies to whom liability for insolvencies is shifted by creation of a guaranty fund are more efficient monitors of potentially weak companies than are consumers.[26]

To test for the possibility of reverse causation—that guaranty fund laws were passed first in states with relatively low frequency of insolvencies, where industry opposition would presumably be weakest—we included the guaranty fund variable in the estimating equations for the two insolvency samples that predate the passage of guaranty fund laws. The coefficients are indeed negative, but beta coefficients and t-ratios are lower than in the 1965–1975 sample. Thus, the correct interpretation of the negative correlation between guaranty funds and the number of insolvencies remains uncertain.

A similar ambiguity of interpretation applies to the uninsured motorist/subrogation dummy variable. Contrary to predictions, this variable is significantly positive in all three insolvency equations. The most plausible explanation is one of endogeneity—that uninsured motorist laws with subrogation rights have been passed in states with a high frequency of insolvencies. The passage of these laws has not sufficed to reduce the insolvency rate below that in states without such laws. Obviously it is still possible that the laws have reduced the number of insolvencies below what it would otherwise have been.

Persistently adverse underwriting results, measured by the maximum three-year moving average loss ratio, increase the frequency of insolvencies in the two samples that include mutuals and small companies.[27] Controlling for the maximum three-year average, the overall seven-year average loss ratio has a negative effect, which is counterintuitive.[28]

These three samples, drawn from different company populations and different time periods suggest several conclusions on the causes of insolvencies.

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[26] It is also consistent with the hypothesis that under a guaranty fund, the other companies exert pressure on the Commissioner to use alternatives, such as rehabilitation or reinsurance, in preference to liquidation. This raises the question of the extent to which the frequency of insolvencies is a discretionary variable.

[27] Beta coefficients and t-ratios are larger for the sample from the period 1965–1975, to which the loss ratio data corresponds. The significance of the loss ratio variables in the 1958–1968 sample suggests that interstate differences in loss ratios were similar in the two periods.

[28] Included alone, the average loss ratio is insignificant. The addition of both the three-year maximum and the seven years' average is significant at the 10-percent level.

For the sample of stock companies only, which excludes very small companies, interstate differences cannot be explained by either the characteristics of the regulatory environment or the average state-wide underwriting results.[29] The only variable that is statistically significant is the *UM*/subrogation dummy variable, which should itself probably be viewed as endogenous.

The other two samples include both stock and mutual companies, small as well as large, and span almost two decades, 1958–1975. Comparing beta coefficients, the single most important variable explaining the absolute frequency of insolvencies is the number of companies. Abnormal underwriting results, in particular a sustained period of abnormally high loss ratios, increase insolvencies. This is consistent with our underlying hypothesis that insolvencies are at least in part the (unlucky) outcome of calculated risk taking. If fraud were the whole story behind insolvencies, there would be no reason to observe a positive relation between insolvencies and abnormally bad underwriting results.[30]

Regulation through expenditure or examinations, etc., appears to have no effect. Regulation through minimum capital requirements has no effect independent of its effect on reducing the number of companies operating in a state.

Prior approval rate regulation and insolvency guaranty funds are negatively related to insolvencies. However, the mechanism of the former effect is unclear and the latter effect is probably at least in part attributable to reverse causation. Thus, there is little evidence that any of the several forms of solvency regulation has a significant deterrent effect on insolvencies.

3. Characteristics of insolvent companies

■ Our analysis of the insurance firm's choice of risk implies that the probability of insolvency is negatively related to its intangible capital, to its underwriting profit margin, and to the sensitivity of demand for its product to its choice of risk, and is positively related to the ease of withdrawing capital, if insolvency becomes imminent and to the supply price of capital. In this section we perform crude tests of this theory by comparing the characteristics of a sample of firms that have been declared insolvent with a matched random sample of solvent firms.

The insolvency sample consists of insolvencies reported by the National Committee on Insurance Guaranty Funds (NCIGF) for the period 1969–1976 which are also listed in *Best's* within one or two years of the date of insolvency, with data on certain key variables. Of the 47 companies listed by NCIGF, complete data are available on 33, probably the larger firms. Corresponding to each insolvent firm, a solvent firm from the same state and listed in the same year was selected at random from *Best's*.[31] Thus the two samples are

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[29] The adjusted R^2 from the OLS regression is only .038.

[30] By "fraud" we mean establishing a firm with the intention of defrauding policyholders. Our findings are consistent with fraud in a more limited sense—it is a strategy which becomes relatively attractive when underwriting results are bad.

[31] For each insolvency we selected the matched firm by taking the volume of *Best's* for the year in which the insolvent firm was last listed, choosing a page by using a table of random numbers, and then proceeding through *Best's* to the first firm domiciled in the same state as the insolvent firm. By matching firms by year of insolvency there is no bias in comparing ages of insolvent and surviving firms.

TABLE 6

COMPARISON OF CHARACTERISTICS OF INSOLVENT COMPANIES WITH A MATCHED RANDOM SAMPLE OF SOLVENT COMPANIES

	INSOLVENT COMPANIES		RANDOM SAMPLE OF COMPANIES	
	n	%	n	%
I. OWNERSHIP:	(N=37)		(N=33)	
(1) DEFINITELY HOLDING COMPANY SUBSIDIARY	21	(56.8)	12	(36.4)
(2) PROBABLY HOLDING COMPANY SUBSIDIARY	2	(5.4)	2	(6.1)
(3) INSURANCE GROUP	6	(16.2)	6	(18.2)
(4) MUTUAL	2	(5.4)	7	(21.2)
(5) CLOSELY HELD STOCK COMPANY	6	(16.2)	5	(15.2)
(6) WIDELY HELD STOCK COMPANY	0	(0)	1	(3.0)
SIGNIFICANCE: .295				
II. NUMBER OF STATES LICENSED:	(N=37)		(N=33)	
1	9	(24.3)	7	(21.2)
2–5	8	(21.6)	6	(18.2)
6–10	4	(10.8)	1	(3.0)
>10	16	(43.2)	19	(57.6)
SIGNIFICANCE: .499				
III. NUMBER OF LINES WRITTEN:	(N=37)		(N=33)	
1–5	14	(37.8)	14	(42.4)
6–10	16	(43.2)	9	(27.3)
>10	7	(18.9)	10	(30.3)
SIGNIFICANCE: .322				
IV. NUMBER OF COMPANIES WRITING AUTO	(N=37)		(N=33)	
	34	(91.9)	23	(69.7)
SIGNIFICANCE: .038				
V. NUMBER OF YEARS IN OPERATION:	(N=5)		(N=50)	
1–5	5	(13.5)	3	(9.1)
6–10	5	(13.5)	2	(6.1)
11–99	27	(73.0)	26	(78.8)
>99	0		2	(6.0)
SIGNIFICANCE: .505				
VI. NET PREMIUMS WRITTEN ($000):	(N=36)		(N=33)	
<$2M.	11	(30.6)	14	(42.4)
$2–$5M.	16	(44.4)	3	(9.1)
$6–$10M.	5	(13.9)	5	(15.2)
>$10M.	4	(11.1)	11	(33.3)
SIGNIFICANCE: .006				
VII. NUMBER UNDER SAME MANAGEMENT ≤ 5	(N=37)		(N=33)	
	20	(54.1)	6	(18.2)
SIGNIFICANCE: .004				

matched by year and state. Table 6 presents a comparison of the characteristics of the insolvent and solvent firms.[32]

Most striking is the almost total absence of the stereotype, self-contained, widely held stock company. The majority of firms in both samples are either

[32] The number of firms in the insolvency sample varies, because for a few firms data were incomplete.

holding company subsidiaries or members of an insurance group.[33] One reason for the formation of holding companies may be to facilitate the withdrawal of capital if insolvency becomes imminent. This theory would predict a higher frequency of the holding company corporate structure in the insolvency sample. The percentage of firms that are definitely part of a holding company is 56.8 percent for the insolvencies, and 36.4 percent for the solvent firms. However, the test for difference in the overall distribution of ownership types is only significant at the 30-percent level.[34]

The number of states in which a firm is licensed and the number of lines of insurance written are not significantly different between the two samples. Thus insolvencies are not confined to single-state, single-line firms. This conclusion is based on only 79 percent of the insolvencies listed by the NCIGF, and the omitted companies are probably smaller on average. Since the control group is also drawn from *Best's*, the comparison is not necessarily biased. However, in terms of net premiums written, insolvent firms are significantly smaller than surviving firms.[35]

There is no significant difference in the number of years in operation between the two samples. However, since many of the firms changed names and affiliations with other firms since incorporation, years in operation may be a very poor proxy for intangible capital. Interestingly, a much larger percentage of the insolvent firms had undergone a change of management within the last five years. Whether a change of management is a cause rather than an effect of imminent insolvency remains an unanswered question.

Although there is no significant difference in the total number of lines written by firms in the two groups, a much larger fraction of the insolvent firms were writing automobile insurance (92 percent compared with 70 percent). There are at least two possible explanations of this finding. First, automobile insurance is one of the more competitive lines of insurance. The underwriting profit margin is probably lower than in other lines, and hence the firm's optimal probability of insolvency higher. Second, automobile insurance is unique in being compulsory in many states. Policyholders who purchase insurance merely to satisfy requirements are presumably more likely to select a low cost, low quality product, and have relatively low incentives to monitor the quality of the insurer. A compilation by the U.S. Senate Subcommittee on Antitrust and Monopoly listed 109 insolvent property-casualty insurers for the period 1958–1968. Of the total, 108 were providing automobile insurance and 106 were writing high-risk drivers (Olson, 1970). To the extent drivers are correctly categorized as high-risk, this suggests that there is a disproportionate number

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[33] This precludes use of the ratio of market value to book value as a measure of intangible capital.

The proliferation of separate but connected companies may be in part a response to various regulations, in particular, restrictions on charging discriminatory rates to policyholders and restrictions on writing certain combinations of lines within the same company. In addition, this proliferation may reflect the desire to avoid the application of regulations in the most stringent state to business written in states with less stringent regulation.

[34] Determining the type of ownership from the description in *Best's* involved judgment, so conclusions based on this variable are tentative.

[35] To test for the possibility that this might be a reporting "error" due to the incentives to understate net premiums as insolvency becomes imminent, we also compared net premiums written four years previously. We confirmed the finding that insolvent firms are typically smaller.

TABLE 7

DETERMINANTS OF THE PROBABILITY OF INSOLVENCY

	LOGIT COEFFICIENT	t–RATIO[a]	PROBIT COEFFICIENT	DERIVATIVE OF PROBABILITY FUNCTION AT MEANS	t–RATIO[a]
YEARS IN OPERATION	–.000691	(–.381)	–.00418	–.00163	(–.385)
HOLDING CO. AFFILIATE[b]	1.148	(1.769)	.650	.254	(1.719)
NUMBER OF STATES LICENSED	–.029	(–1.436)	–.0162	–.00634	(–1.347)
NUMBER OF LINES WRITTEN	.013	(.153)	.00869	.00340	(.182)
AUTO[b]	1.998	(2.459)	1.135	.443	(2.479)
NET PREMIUMS WRITTEN	–4.439 D–05	(–1.515)	–.265 D–04	–.104 D–04	–1.449
MANAGEMENT CHANGE WITHIN 5 YEARS[b]	1.235	(1.777)	.670	.262	1.706
CONSTANT	–1.562	(–1.566)	–.890	–.348	–1.612

[a] APPROXIMATE t–RATIO.
[b] BINARY VARIABLE.

of policyholders of insolvent firms who would consciously select a relatively high-risk insurer. This tends to undermine the case for solvency regulation to protect uninformed policyholders, although not necessarily the case for it to attempt to protect claimants against them.

We next tried to measure the contribution of these characteristics to the probability of insolvency. In the equations reported in Table 7, the dependent variable takes the value of one if the firm became insolvent and zero if it survived. Thus the coefficients are to be interpreted as the effect on the probability of insolvency.

Probit and logit estimates are reported.[36] The conclusions are robust under the two alternative specifications. Writing automobile insurance is the single most important variable. Affiliation with a holding company and a recent change of management are also positively associated with the probability of insolvency. Each alone is not highly significant. This partly stems from collinearity between them.

In conclusion, the evidence from this comparison of characteristics of solvent and insolvent firms is consistent in several respects with the theoretical model of insolvency as the unlucky outcome of expected-value-maximizing risk-taking. Insolvent firms are more likely to be writing automobile insurance, a highly competitive line with a disproportionately large percentage of involuntary policyholders. They are more likely to be holding-company affiliates, which may indicate a relatively high preference for risk and ease of withdrawing capital. They have undergone recent management change, which indicates a high cost of capital. Finally, they are relatively small, and hence presumably have a relatively small stock of intangible capital.

[36] The logit coefficients are to be interpreted as the effect on the log of the odds ratio.

References

Best's Insurance Report—Fire and Casualty. Oldwick, N.J.: A. M. Best Co., Inc., annually.

Best's Review—Property/Casualty Insurance Edition. Oldwick, N.J.: A. M. Best Co., Inc., annually.

IPPOLITO, R.A. "The Effects of Price Regulation in the Automobile Insurance Industry." *Journal of Law and Economics*, forthcoming.

JOSKOW, P. "Cartels, Competition, and Regulation in the Property-Liability Insurance Industry." *Bell Journal of Economics*, Vol. 4, No. 2 (Autumn, 1973).

MAYERSON, A.L. "Ensuring the Solvency of Property and Liability Insurance Companies" in S.L. Kimball and H.S. Denenberg, eds., *Insurance, Government, and Social Policy*, 1969.

MCKINSEY AND CO., INC. *Strengthening the Surveillance System*. National Association of Insurance Commissioners, April 1974.

MEADOR, N.W. AND THORNTON, J.H. "The NAIC Early Warning System: A One-State Review." *Best's Review* (July 1978).

MUNCH, P. AND SMALLWOOD, D.E. "Solvency Regulation in the Property and Liability Insurance Industry: Empirical Evidence." The Rand Corporation, Santa Monica, P-6349. June 1979.

NATIONAL ASSOCIATION OF INDEPENDENT INSURERS. *Capital and Surplus Requirements: Summary of State Laws and Regulation Relating Thereto*. Chicago: 1968.

NATIONAL ASSOCIATION OF INSURANCE COMMISSIONERS. *Monitoring Competition*. Milwaukee: May 1974.

OLSON, D.G. *Insolvencies among Automobile Insurers, U.S. Department of Transportation*. July 1970.

SENATE COMMITTEE ON THE JUDICIARY, SUBCOMMITTEE ON ANTITRUST AND MONOPOLY. U.S. Congress, 91st Session, Hearings on the Insurance Industry, Part 15. Washington, D.C.: 1970. (Hart Committee.)

SENATE COMMITTEE ON COMMERCE. U.S. Congress, 91st Session, Hearings on S.2236, A Bill To Create A Federal Insurance Guaranty Corporation. Washington, D.C.: 1970. (Magnuson Committee.)

SMALLWOOD, D.E. AND MUNCH, P. "Solvency Regulation in the Property and Liability Insurance Industry." NBER 1977, forthcoming.

STATE OF NEW YORK INSURANCE DEPARTMENT. *Regulation of Financial Condition of Insurance Companies*. March 1974.

U.S. DEPARTMENT OF JUSTICE. *The Pricing and Marketing of Insurance*. 1977.