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On the Capital Structure and Regulation of Insurance Firms

Neil Doherty

College of Commerce and Business Administration
Bureau of Economic and Business Research
University of Illinois, Urbana-Champaign

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Neil Doherty, Professor
Department of Finance

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ABSTRACT

Regulations designed to constrain the capital structure and reduce the probability of ruin of insurance firms are pervasive. These usually are explained by the need to protect consumers who cannot monitor the financial condition of insurers. A complementary rationale for regulation is developed that focusses on the benefits of such regulation to the firms' equity holders. In the absence of monitoring information, insurers face prospective erosion of demand through adverse selection. Regulations act as quality signals (that no "lemons" exist) that prevent demand erosion. But equityholders also benefit when monitoring information is costlessly available. Regulations bond the equityholders to avoid post contract wealth expropriations from policyholders. Equityholders benefit from such bonding since, in the absence of regulation, such time inconsistent incentives would lead the insurer to suboptimal decisions on capital structure and other financial variables.

I. INTRODUCTION

The value of an existing insurance contract depends upon the financial ability of the insurer to make good on its promise to meet state contingent claim payments. Regulation aimed at increasing this value is pervasive. Most states, and indeed national jurisdictions, require insurers not to exceed prespecified leverage ratios, i.e., the ratio of premiums to shareholders' equity or surplus. Empirical evidence has revealed this ratio to be associated with financial distress (cf. Pinches and Trieschman). Furthermore, an extensive actuarial literature has shown that an analytic relationship exists between leverage and the probability of ruin of the insurer.[1]

Complementary regulation includes constraints imposed on the composition of the insurer's asset portfolio. The form of such regulation varies considerably across jurisdictions but the general effect is to preclude or limit investment in high risk assets. Again, the perceived intention is to reduce the prospective loss to policyholders should the insurer become insolvent. The final safety net comes in the form of the insolvency guarantee systems operated by the States. Surviving insurers make good outstanding payments in the event that one of their competitors becomes insolvent. Such schemes resemble the Federal Deposit Insurance Corporate with the main difference being that most state insurance guarantee schemes are post funded by assessments on surviving insurers.

The rationale for such solvency regulation usually offered relates to the difficulty faced by consumers in evaluating the financial condition of insurers. Since such information is costly, the insurer may take actions that increase the prospective default loss faced by consumers. Such actions would not necessarily be reflected in the prices of insurance policies. As a result, equityholders would be able to expropriate wealth from policyholders (see Munch and Smallwood [1981]; Finsinger and Pauly [1984]). From this rationale we may suppose that, in a world in which consumers could perfectly monitor the financial condition of insurers, solvency regulation would be redundant. Any increase in the prospective default loss to be borne by the consumers would be impounded in the price of the insurance contracts, and therefore fall on the equityholders. Consumers may well choose risky policies from a menu of offerings, but they would do so in full knowledge of the ruin probability and they would pay a correspondingly lower price. Thus the rationale for solvency regulation arises from the perceived need to protect consumers in the event of costly information.

The current paper enriches the rationale for solvency regulation. We will show that insurance firms have an incentive to submit to regulation. Furthermore, we will show that this incentive for self regulation is present both when consumers can monitor the financial condition of the insurance firm and when they can not. When consumers cannot monitor the insurer's financial condition an adverse selection problem will exist. To prevent erosion of market demand, insurers will benefit from the collective imposition of some combination of regulatory controls; notably guarantee funds and/or leverage constraints. But even when consumers can monitor financial condition, insurers will face time inconsistent incentives. They may choose actions that expropriate wealth from policyholders after the insurance contracts have been written. No doubt, consumers would anticipate such behavior and price it into the insurance contract thereby reshifting costs back to equityholders and forcing the firm into sub optimal financial decisions. In this situation, solvency regulation provides a bonding mechanism, in which insurers commit themselves to not indulge in post contract expropriations.

II. ASSUMPTIONS AND BASIC RELATIONSHIPS

The required assumptions are:

(1) Capital markets are complete and in a state of competitive equilibrium. This permits use of the value maximization objective.

(2) Taxes are not considered.

(3) There are no transaction costs associated with the "ruin" of the insurance firm.

(4) There are no agency costs arising from the relationship between the owners of the insurance firm (as principals) and its managers (or agents).

(5) Contracts are presented in a simple single period framework in which all cash flows arise at the beginning or end of the contract. The firm is sold (perhaps back to its original equityholders) at the end of the period for its terminal market value.

The insurer will be considered to be a leveraged financial intermediary. At the beginning of each period the firm issues new equity (or inherits equity from a previous period) and insurance policies. The proceeds are used to construct an asset portfolio. At the end of the period, the value of the asset portfolio is used to discharge policyholder claims; the residual value accruing to equityholders. The opening cash flow is

$$(1) \qquad Y_0 = E + P - X$$

where E is paid in equity (or surplus in insurance terminology), P is premium income and X is the insurer's production and marketing expenses which are assumed to be incurred up front. The proceeds net of expenses are invested. However, the firm is subject to a regulatory constraint that in effect, forces it to invest a certain proportion c of its opening value in assets of low risk yielding a return r_c. The residual proportion (1-c) may be invested without constraint yielding a risky return r_i. Thus the terminal value of the portfolio is

$$(2) \qquad Y_1 = (E+P-X)(1+r_i) - c(P-X)(r_i-r_c)$$

The policyholders will receive the assessed value of losses L if Y_1 is sufficiently large, otherwise they will receive Y_1 (if positive) leaving nothing for equityholders. Thus the terminal value of the policyholders claim may be written

$$(3) \qquad H_1 = MIN(L, Y_1, 0)$$

This payoff structure has the characteristics of a European option and we may write its present value as

$$H_0 = V(Y_1) - c(Y_1,L) \equiv V(H_1) \tag{4}$$

where $V(\cdot)$ is the present value operator and $c(M,N)$ is a European call option written on M with striking price N. In fact the striking price here, L, is stochastic, but this should not cause great problems.

Since we ignore taxes, the residual value of the asset portfolio accrues to equityholders. Consequently, the present value of the equity claim is

$$\begin{aligned} V(E) &= V(Y_1) - H_0 \\ &= c(Y_1,L) \end{aligned} \tag{5}$$

III. CAPITAL STRUCTURE AND SOLVENCY REGULATION IN THE ABSENCE OF MONITORING

Consider that consumers cannot monitor the financial condition of the insurer. It follows that the prices consumers are willing to pay for the policies offered by different companies are insensitive to their respective financial conditions, and insensitive to their respective choices of leverage. In this situation, it is easily shown that the optimal level of equity E to be held for any given premium income P, is zero. The assumed objective is that the insurer wishes to maximize the value added to its equity (surplus) contribution, i.e.,

$$\max_{E} V(E) - E \tag{6}$$

Since, by assumption the capital market yields equilibrium expected returns on financial assets, it follows that

(7) $V(Y_1) = Y_0 = E + P - X$ since $V(1+r_i) = V(1+r_c) = 1$

Now, $dV(Y_1)/dE$ must equal unity since P is insensitive to choice of equity by the information assumption. Any change in E will increase the value of the equity call (equation 5), since it increases the value of the underlying asset Y_1 on which the call is written. But with any nonzero probability that the option will expire worthless (a nonzero probability of ruin) the call cannot increase by greater value than the underlying asset.[2] Consequently

$$0 < d[c(Y_1,L)]/dE < 1$$

Using these properties and returning to the objective function (6)

(6) $$\underset{E}{MAX}[V(E)-E] = \underset{E}{MAX}[c(Y_1,L)-E]$$

The derivative is negative

(8) $$\frac{d[c(Y_1,L) - E]}{dE} < 0$$

(except in the limiting case where the probability of ruin is zero). Since the insurer cannot provide negative equity the value maximizing choice of E is zero. Notice also that reductions in E imply a wealth transfer from policyholders to equityholders since

(9) $$\frac{dH_0}{dE} = \frac{dV(Y_1)}{dE} - \frac{dc(Y_1,L)}{dE} > 0$$

A similar result has been derived elsewhere using a long term profit maximization objective (cf. Munch and Smallwood [1981] and Finsinger and Pauly [1984]). In fact, they also examine possible positive capital structures by postulating costs to insolvency in the form of "re-entry" cost. Nevertheless, the case does illustrate the possibility for wealth expropriation by equityholders, thereby fueling the argument for leverage regulation in the interests of consumer protection.

But regulation may also benefit equityholders. An alternative rationale for solvency regulation has been hinted at somewhat briefly by Lynch [1981]. Insureds may not be able to monitor the leverage ratios chosen by individual insurers, but they may well recognize the incentive for wealth expropriation. Figure 1 shows the utility function for a representative policyholder having wealth OA. There is a probability of a total loss of wealth such that the expected value of uninsured wealth is OB. Without insurance, expected utility is OU_2. If a riskless insurance policy were available at premium AC, insurance would be preferred, as shown by the utility level OU_1. Insureds cannot monitor default probabilities but, recognizing incentives for wealth transfer, presume such costs to be high. The expected loss in value of the insurance policy due to default is DC (which cannot exceed BA). Consequently the expected utility to the insured from the risky insurance policy is OU_3.

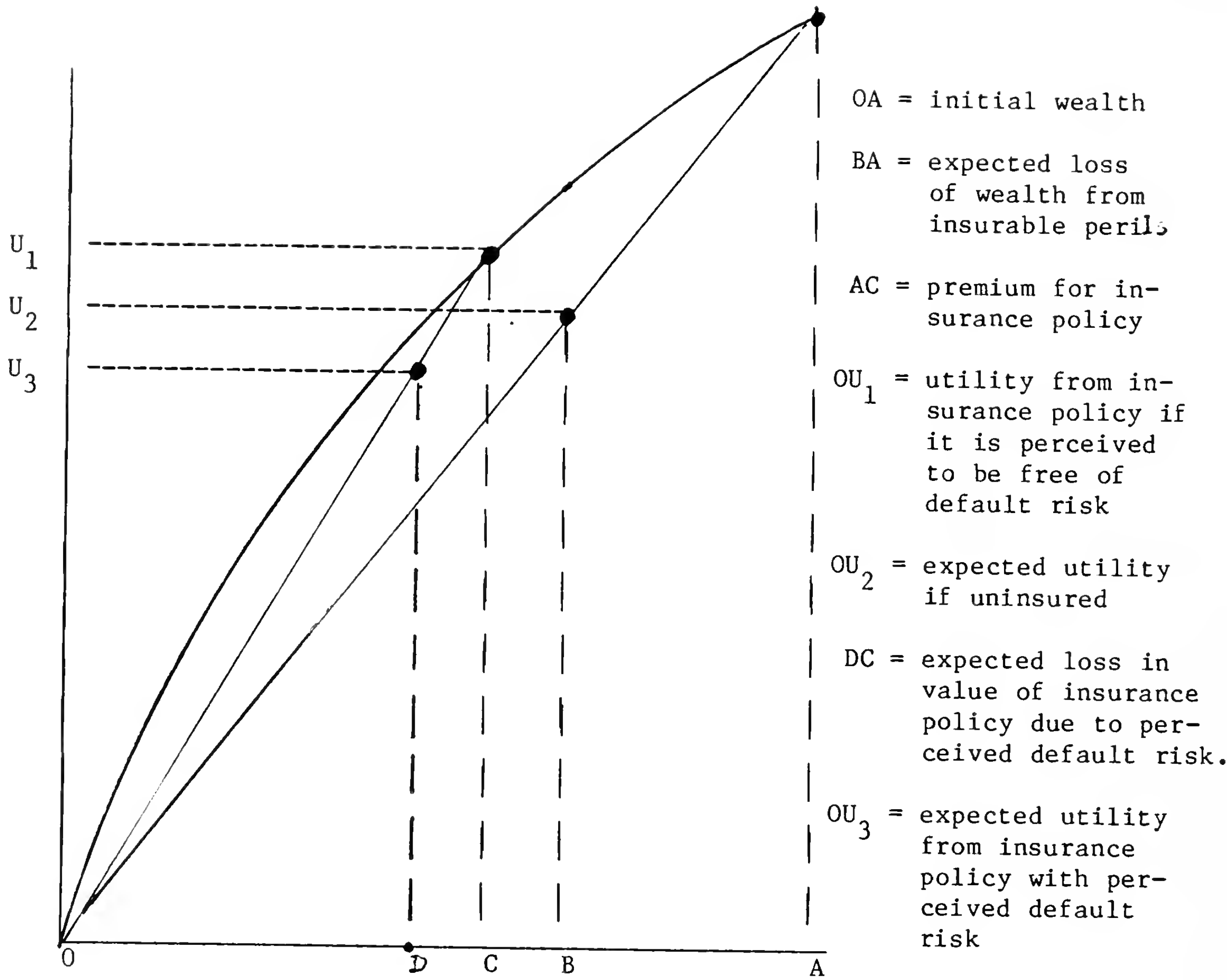


Figure 1

As drawn, insurance would not be purchased even though the actual default risk may be lower than indicated. The problem is that insureds, unable to monitor prospective loss of value in default, will fear the worst; that all insurer's are "lemons" (cf. Ackerloff [1970]; Rothschild and Stiglitz [1977]). The dynamic effect of such adverse selection will be a progressive erosion of the demand for insurance. Existing insurers will be tempted to reduce equity (increase leverage). Over time,this will lead to more insurance company failures which will make policyholders even more circumspect about default risk; and so on.

In such conditions, insurers may well lobby their legislators for regulatory control to prevent such demand erosion. Two forms of such regulation will be examined, leverage constraints and insolvency guarantee schemes. Consider that the insurance firms successfully lobby for an upper constraint on leverage, or P/E, to be imposed on all insurers. Insofar as default risk is associated with leverage, this represents a signal to the market that no "lemons" exist. Of course, there is some noise in this signal since (a) variations in leverage are permitted within the constraint and (b) other factors may affect default probability. Nevertheless, it does provide a signal of minimum quality to the market which is helpful in maintaining aggregate demand for insurance policies.

A somewhat stronger quality signal may be sent in the form of a collective guarantee offered by all insurers to honor outstanding claims in the event that one of their number default through insolvency. With such a guarantee scheme, default losses imposed upon policyholders depend upon the collective strength of the industry rather than the leverage of the individual insurer. Participation in such a fund may or may not affect the financial decisions of the insurer. For example, if the levies to each insurer were related to the expected value of default loss (e.g., positively related to leverage), then any confiscation of policyholder wealth through increased leverage would, in fact, be passed back to equityholders in the form of higher assessments in the insolvency guarantee scheme. In fact, most existing schemes do not work in this way; the schemes are not prefunded. After an actual insolvency, the remaining insurers are assessed for outstanding liabilities in proportion to premium income. This conveys little or no incentive for leverage control. Thus, the scheme implies a set of cross subsidiaries between the shareholders of high default risk and low default risk insurance firms. Given such subsidies, insurers would wish to eliminate high default risk insurers from the market. Constraining leverage by regulation provides an appropriate mechanism to limit such cross subsidies.[3]

The rationale for regulation developed here rests upon the absence of monitoring such that the financial condition of the insurer is not reflected in its contract prices. Given the nature of insurance markets it would be somewhat surprising if prices did not impound some information on default probabilities. Consumers make extensive use of professional intermediaries, independent agents and brokers, who make available price/quality information. Furthermore, the market is serviced by a rating agency (A. M. Best and Company) that produces ratings of financial condition, analogous to bond ratings. We now address capital structure and solvency regulation in the face of complete monitoring information.

IV. CAPITAL STRUCTURE AND SOLVENCY WITH MONITORING

IV.(a) Capital Structure When the Firm is a Price Taker

In the presence of perfect monitoring, the insurance premium P reflects the value of the insurance portfolio H_0 (equation 4) but includes a markup $p = (1-k)^{-1}$ for expenses and profit.

$$P = pH_0 = [V(Y_1) - c(Y_1, L)](1-k)^{-1} \tag{11}$$

Expenses X will be assumed to be functionally related to the market value H_0. Accordingly if average costs $x \equiv X/P$ equal to k, the firm will not earn any excess profit, i.e., it will earn a competive expected rate of return on equity. Such a premium would prevail in a competitive insurance market. The case of a "price taker" is defined such that the demand for insurance is perfectly elastic at the exogenously determined k. Such a value may be set either by competitive process or by regulation. The latter case permits k to diverge from x.

In examining capital structure, it is noted that leverage depends both on the choice of output and the choice of surplus. The market value of liabilities H_0 will be used as the output measure and, as before, the choice of surplus is E. The firm again maximizes the increase in its value of equity

(12) $$\underset{H_0 E}{\text{MAX}}[V(E) - E] = \underset{H_0 E}{\text{MAX}}[c(Y_1, L) - E]$$

Substituting (7) into (11) yields

(13) $$c(Y_1, L) = E + H_0[\frac{k-x}{1-k}]$$

The first order conditions are

(14a) $$\frac{d[c(Y_1,L) - E]}{dH_0} = (1-k)^{-1}[k - x - H_0 \frac{dx}{dH_0}] = 0$$

(14b) $$\frac{d[c(Y_1,L) - E]}{dE} = (1-k)^{-1}[k - x - H_0 \frac{dx}{dH_0}]\frac{dH_0}{dE} = 0$$

Several solutions may be noted.

(a) A long run competitive solution may be attained if k = x and the firm chooses output at the minimum point on the average cost curve, $dx/dH_0 = 0$. At this level of output both conditions (14a)and (14b) are satisfied whatever the level of surplus E since the common square bracket is zero. Thus, in a perfectly competitive market with firms producing at their least cost level of output, capital structure is irrelevant.

(b) The firm may capture rent (e.g., through regulated prices) if $k > x$. In this case, satisfaction of (14a) requires that the firm produce at an output level reflecting diseconomies of scale, $dx/dH_0 > 0$. This may be possible with a "U" shaped average cost curve. At such an output level, the square bracket in (14a) may be equated to zero which will also ensure satisfaction of (14b) whatever the choice of surplus E. In this case also, the capital structure is irrelevant if the firm selects its value maximizing level of output.

(c) Now suppose $k > x$ but the firm does not exhibit increasing returns at any output level, i.e., $dx/dH_0 \leq 0$ for all H_0. Conditions (14a) and (14b) cannot be satisfied (except in the trivial cases where $k = 1$ or $dH_0/dE = 0$). Thus (14a) and (14b) will both be positive since dH_0/dE is positive (equation 9). The optimal output and the optimal surplus both are infinite.

(d) For completeness, it should be added that if $k < x$, a zero level of surplus may be optimal. This case is not too interesting since the required return on equity is insufficient to maintain capital to the industry and presumably the supply of insurance services would dry up.

IV.(b) <u>The Choice of Capital Structure When Demand is Price Sensitive</u>

The firm may now choose either price or output since its demand function is assumed to be downwards sloping. We will further generalize the discussion by permitting demand to be sensitive to the choice of equity. The rational for the latter relationship rests on the default probability. If an insurance policy is risky in the sense that it carries a non zero probability of default, it is not efficient in reducing the dispersion of wealth across states of nature. Consequently, such a policy would be less attractive to risk averse consumers than a non risky policy even if both were actuarially priced. Since this relationship is pertinent to the model developed here it is developed more formally in the Appendix. To formalize these relationships we break down output H_0 into nominal and valuation factors

$$(15) \qquad H_0 = m\bar{L}$$

where $\bar{L}$ is the face value of the insurance policies, i.e., the expected value of claim payments in the absence of default. The term m is the average present market value of each dollar of promised expected liability undertaken by the insurer taking account of default risk. Collecting these pieces together

$$(16) \qquad \frac{dm}{dE} > 0; \quad \frac{d\bar{L}}{dE} > 0; \quad \frac{d\bar{L}}{dk} < 0.$$

We now choose the leverage structure that maximizes the value added to the equityholders contributed surplus. Given the demand schedule, $\bar{L} = \bar{L}(E,k)$, we can select either output or price as a decision variable. It is convenient here to choose the latter.

$$(17) \qquad \underset{k,E}{\mathrm{MAX}}[c(Y_1,E) - E]$$

The first order conditions are

$$(18a)\qquad \frac{d[c(Y_1,E) - E]}{dk} = m(1-k)^{-1}[k - x - H_0 \frac{dx}{dH_0}]\frac{d\overline{L}}{dk} + H_0\{\frac{1-x}{(1-k)^2}\} = 0$$

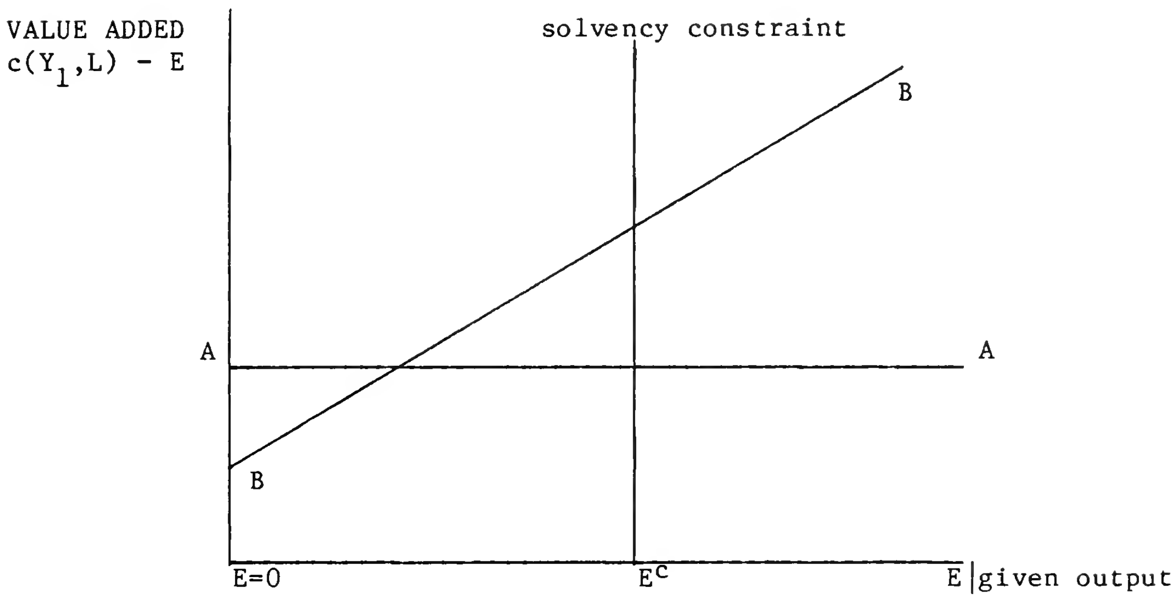
$$(18b)\qquad \frac{d[c(Y_1,E) - E]}{dE} = (1-k)^{-1}\{m \frac{d\overline{L}}{dE} + \overline{L} \frac{dm}{dE}\} [k - x - H_0 \frac{dx}{dH_0}] = 0.$$

The problem now arises that interior solutions to both (18a) and (18b) may not be found. For example, the effect of price sensitivity will be to induce the firm to restrict its output (or equivalently increase its price), such that the square bracketted term in (18a) is positive. This follows since $d\overline{L}/dk < 0$. But this condition precludes an interior solution to (18b) which requires the same square bracketted term to be zero. Thus a possible corner solution to the capital structure problem arises with the following sequence. First output is selected by condition (18a). This implies that (18b) will be positive. Thus the firm selects the maximum possible (theoretically infinite) level of surplus to complement this output choice. Other possible solutions may exist; e.g., by reversing the decision sequence.

The possible capital structure described so far are illustrated in Figure 2.

Figure 2

Possible capital structures with Perfect Monitoring



key AA - irrelevance structures may arise for the price taking firm (a) if $k = x$ and $dx/dH_0 = 0$; or (b) if $k > x$ and dx/dH_0 is positive

BB - positive (infinite) leverage may arise (a) for the price taking firm if $dx/dH_0 \leq 0$ or (b) for the firm facing downwards sloping demand.

Given the capital structures illustrated, it would appear that solvency regulation is irrelevant or redundant to the insurer. With value line AA, constraints on capital structure cannot affect value since value is independent of E. With line BB, constraints or leverage are redundant since the equityholders would rationally choose levels of surplus in excess of any finite constraint such as E^c. Nor can we argue that consumers would have much interest in solvency regulation since they are able to monitor the financial condition of insurers and default risk is properly priced. We now turn to the issue of time inconsistent incentives.

IV(c). Time Inconsistent Incentives and Wealth Expropriation

Consider the following sequence, (i) the insurer makes a set of financial decisions [A] relevant to the default probability; (ii) the insurer then issues policies to customers who may costlessly monitor [A]; (iii) the insurer then substitutes a new set of decisions [A'] which imply a greater default cost to be borne by the policyholders. Such time inconsistent incentives have been analyzed for non insurance firms. For example, the equityholders of a firm may be able to confiscate wealth of bondholders by changing operating decisions or capital structure *after* the bonds have been issued (cf. Myers [1977]; Titman [1984]). No doubt bondholders, or in our case policyholders, will anticipate such pernicious behavior in negotiating their original contracts. This will be addressed presently. First, we illustrate possible forms of time inconsistent incentives and show the value that may be expropriated.

Example 1 Payment of premature dividend to equityholders. Premature, in this case, means after policies are issued but before policy liabilities have been discharged by the payment of claims. At the time of policy issue the value of the equityholders' and policyholders' claims are shown by the earlier equations;

(4) $$V(Y_1) - c(Y_1, L)$$

and

(5) $$c(Y_1, L)$$

Now consider that equityholders pay themselves a dividend, K, immediately before the losses L are known and discharged. The present value of the policyholders' claim is reduced by

(19) $$[V(Y_1)-c(Y_1,L)] - [V(Y_1-K)-c(Y_1-K,L)]$$

Equityholders' benefit by an equivalent value.

<u>Example 2</u> <u>An increase in the size of the liability portfolio without a corresponding increase in surplus.</u> For simplicity we assume that having issued a set of policies yielding P_0 in premiums and having an expected liability E(L), the insurer now issues another set of policies having the same expected liability E(L) but now priced at P_N. Presumably, the original policies were priced on the assumption that the leverage ratio was P_0/E. The new policies are now sold to new customers who monitor the leverage ratio as $(P_0+P_N)/E$. If all policies have equal priority then we may identify the loss in value to the old policyholders as (for simplicity the investment constraint and expenses are ignored, i.e., c=X=0)

(20) $$\{V[(E+P_0)(1+r_i)] - c[(E+P_0)(1+r_i);L]\}$$

$$- \{V[(\frac{E + P_0 + P_N}{2})(1+r_i)] - c[(\frac{E + P_0 + P_N}{2})(1+r_i);L]\}$$

Since new policyholders are aware of the increased default probability, $P_N < P_0$. This implies that old policyholders do indeed lose wealth and equityholders correspondingly benefit. There is no expropriation from the new policyholders.

Example 3 Increase in the risk structure of the insurer's asset portfolio. The policyholders have a short position in a call option written on Y_1 with a stochastic, striking price L. Equityholders have a long position in the same call. Now the value of a rationally priced call will be positively related to the variance of the underlying asset (see Merton [1973]). Our example is a little more complex since the striking price, L, also is stochastic and its correlation with Y_1 is important (see Stapleton and Subrahmanyan [1984], p. 224). For simplicity, the correlation between Y_1 and L is assumed to be zero. This ensures the positive relationship between the variance of Y_1 and the value of the call is maintained. Consequently, an increase in the variance of the asset portfolio will enhance the value of the equityholders' long position in the call and correspondingly reduce the value of the policyholders' short position. Notice that the value of the policyholder's claim also depends upon $V(Y_1)$. But if the new, more risky, assets also are priced at equilibrium, this value will not change with the change in asset composition.

Other examples of such wealth expropriation may be envisioned such as a change in the reinsurance arrangements selected by the insurer.

IV.(d) Solvency Regulation with Monitoring and Time Inconsistent Incentives

Consider that equityholders expropriate wealth as shown in example 1 in the previous section; i.e., by paying a dividend K after the issue of policies but before the payment of claims. The value of wealth expropriated shown in equation (19) is positive monotonic in K. Thus equityholders would pay the largest dividend permissible. In the absence of other regulations, we assume this to be the entire surplus

E. Thus outstanding insurance policies will run off without any surplus; $E = 0$.

Such post contract wealth expropriation would be anticipated by aware and rational consumers and would be priced into the insurance contract. Thus the monitoring price would be

$$(21)\qquad P_{E=0} = [V(Y_1)_{E=0} - c(Y_1,L)_{E=0}](1-k)^{-1}$$

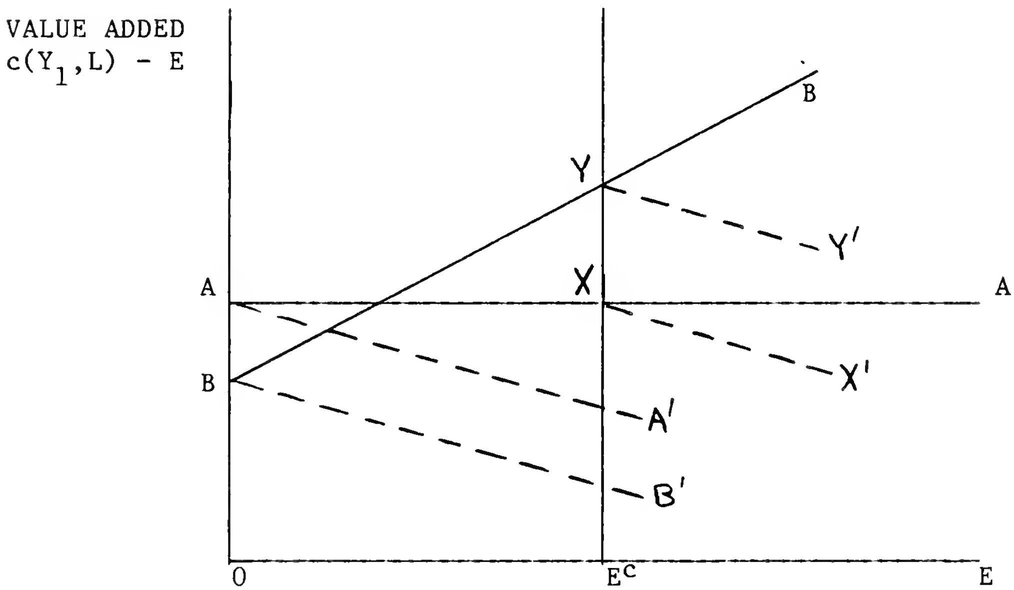
Given that the contract price already impounds the wealth expropriation, insurers would use this price in determining their initial capital structure. In fact, the use of such a price does not change the general characteristics of the output decision (or price decision), (i.e., equations (16a) and (18a)) but it does affect the choice of surplus E; (equations (14b) and (18b)). Since zero surplus is assumed in the pricing decision, then dP/dE is zero. This is similar to the no monitoring case (equation 8) and, for identical reasons, the effect is that

$$(22)\qquad \frac{d[c(Y_1,E) - E]}{dE} < 0$$

which implies a zero precontract choice of surplus, $E = 0$. There is no advantage to insurers in providing positive surplus since it will not change the price paid by consumers for their policies. These contracts are priced on the assumption of zero surplus and that is what would be provided by equityholders. There is no longer any incentive to switch from a pre contract level of surplus to a different post contract level since the wealth expropriation already has been anticipated.

Now consider the effects on solvency regulation. The possible capital structures shown in Figure 2 are reproduced in Figure 3. These were constructed in the absence of time inconsistent incentives. The effects of time inconsistent incentives are shown by the dotted lines AA' and BB'. Also shown is a leverage constraint. Since output is given, a fixed level of E, i.e., E^c, corresponds to a fixed ratio of surplus to policy liabilities. Insurers cannot fall below this level.

Figure 3



First we address the case in which choice of surplus was irrelevant as shown by line AA. The introduction of time inconsistent incentives leads to the alternative AA' as indicated by inequality (22). Now zero surplus creates most value for shareholders. However, the wealth of equityholders has not been diminished since the zero surplus solution was one of an infinite number of solutions derived on AA that all yielded the same value added for equityholders. The introduction of the leverage constraint leaves equityholders no better off or no worse off as shown by position X. If surplus is increased beyond X, the value of equity will fall as shown by the line XX'. This follows since the condition (22) is negative at any fixed price. Thus producers would lend to cluster at the constrained leverage ratio, i.e. at position X.

The second case in Figure 3 arises with line BB. In the absence of time inconsistent incentives, the level of surplus that maximizes value added is infinite. But time inconsistent incentives reduce the optimal surplus to zero as indicated by BB'. There is a clear wealth loss to equityholders. Regulation permits some of this wealth loss to be recaptured by moving surplus to the constraint E^c. Now, consumers will anticipate the post contract choice of E^c surplus and this will be priced into the contract. Consequently, this level is chosen by equityholders. This is shown by position Y. Increases in surplus beyond E^c would not be chosen as value added still is negative in E as shown by the line YY'.

It is also possible that consumers benefit from such regulation. The effect of regulation is that consumers are offered policies with a higher level of surplus and therefore a lower probability of default. If the demand function is positive in E as indicated, then by reaping the "consumer surplus" (not to be confused with the insurance surplus or "paid in" equity) the consumers secure a welfare gain. The high surplus policies are more efficient at equalizing wealth in states of nature thus leading to a richer (more complete) market in contingent claims. The Appendix illustrates that the high surplus/low default risk policies are more attractive than the low surplus/high default risk policies; the former being in higher demand.

IV.(e) Discussion of Multi Period and Related Issues

The use of a single model to illustrate the effects of time inconsistent incentives simplifies at the expense of exaggeration. In a multiperiod setting, there may well be mutual recognition by firms and consumers, that firm's intending to stay in business will not undertake post contract expropriations. Thus, for many firms, the expropriations may not be anticipated in price as indicated. But this may not be true for all firms and at all times. Property liability insurance exhibits a distinct cycle in terms of profitability and in terms of entry and exit of firms from particular markets (see Stewart [1981] and Doherty and Kang [1984]). Thus, in consumers minds there may be considerable uncertainty about whether a particular firm will leave the industry or withdraw from writing a particular line of business. This uncertainty likely will be heightened during the low ebb of the cycle. In such circumstances we would expect the contract prices for each firm to reflect the probability that post contract reductions in surplus may be undertaken. Such behavior again suggests that insurance contract prices may be relatively insensitive to the pre contract choice of surplus. The consequence is that insurers would choose levels of equity that do not maximize value and that they will benefit from regulation that bonds them to certain minimum leverage ratios.

In such conditions we can also explain why insurers may not all cluster at the constrained leverage ratio. Many stronger firms who are perceived to be unlikely to undertake post contract expropriations may face upward sloping value curves such as BB in Figure 3. Since the consumers do not anticipate expropriation it is not priced into the contract and the value added line does not pivot down to the BB'. Consequently these firms would voluntarily choose leverage ratios within the contraint (to the right of E^c).[5]

Existing controls on portfolio composition may be similarly rationalized. Such controls aim to reduce the risk of the liability portfolio. Insofar as this aim is achieved, these controls limit possible wealth expropriations that may be achieved by switching into a high risk portfolio strategy.[6]

The third form of control addressed early, solvency guarantee schemes, also may be rationalized with respect to time inconsistent incentives. Since the guarantee is given, the policyholders are indemnified from possible wealth expropriations after contract issue. However, individual insurers still might expropriate wealth from their competitors. Any expropriations that might have been targetted at policyholders are now simply spread over all insurance firms who collectively assume liability for any outstanding claims in default. Clearly, all insurers would wish to prevent individual firms from undertaking such expropriations. Since assessments under the scheme are not risk related, as discussed earlier, there is a strong incentive for insurers collectively to prevent cross subsidization by the regulatory constraints mentioned, leverage control, and asset composition control.

CONCLUSION

1) Modigliani and Miller's capital structure irrelevancy proposition does not necessarily prevail in insurance markets given the strong

capital market assumptions they propose. This exception arises from the inseparability of financing and operating decisions. We identify exceptions to M and M. A necessary, but not sufficient, condition for irrelevancy is that the firm be a price taker in the insurance product market.

2) Regulation of leverage and other financial variables may bring benefit to consumers and equityholders alike in a market in which financial monitoring does not occur. These results are reformulations of earlier literature.

3) Examples of post contract wealth expropriation arising from time inconsistent incentives are given. These include premature dividends, expansion of the insurance liability portfolio and restructuring of the firm's reinsurance portfolio.

4) Even in the presence of perfect monitoring regulation may still bring benefit to equityholders and consumers. The time inconsistent incentives identified lead to inefficient capital structure decisions. Moreover, consumers will be offered a menu of policies with high default risk. Regulation permits insurers to recapture some of the loss in value due to time inconsistent incentives. Regulation also leads to an available offering of policies with lower default risk permitting consumers a more complete choice of risk management options.

5) An ancilliary result is generated in the Appendix. A risk averse individual will not fully insure if offered an actuarially fair but risky insurance policy. This result is a further exception to the Bernoulli principle.

Footnotes

[1]Using mean variance portfolio analysis, Kahane [1977] has questioned whether leverage regulation alone is sufficient to constrain the ruin probability of the insurer.

[2]The proof that a call option cannot increase by a value greater than the increase in value of the underlying asset is as follows. consider the call c(Y,L) and then increase the value Y by some arbitrary positive K. The call written on c(Y,L) and the call written on c(Y+K,L) have the following payoffs at maturity.

Payoff in states where:

	1. $Y \leq L-K$	2. $L-K \leq Y < L$	3. $L < Y$
c(Y,L)	0	0	Y-L
c(Y+K,L)	0	Y+K-L	Y+K-L
additional payoff on second call	0	$Y+K-L < K$	K

Notice that additional payoffs only arise in the second and third columns. But the additional payoff in the second column Y+K-L must be less than K since $Y < L$. Therefore a payoff of K, or strictly less than K, arises in all states of nature.

Now consider the increase in value of the underlying asset. The payoff increases by K (from Y to Y+K) in all states of nature. Consequently, the increase in value of the call option cannot exceed the increase in the value of the underlying asset in equilibrium.

[3]Consider the alternative signals, (a) a guarantee scheme with assessment related to insolvency risk and (b) a scheme without risk related assessment but with regulatory constraints of the leverage ratios of insurers. In terms of resource allocation (a) may appear more efficient since costs are internalized to the decision maker. However the information required to administer a risk related assessment scheme is costly. In light of such costs, it is feasible that combination (b) could be a "first best" solution.

[4]Evidence on the performance of the capture theory and competing theories of price regulation in insurance was recently surveyed by Harrington [1984].

[5]See Borch [1981] for a discussion of related issues.

[6]The structure of insurance investment regulations may not be too effective in limiting portfolio risk. With so many different state regulations it is difficult to generalize. However, most regulations address the riskiness of individual securities rather than the risk of the portfolio. For example, many jurisdictions limit the proportion of common stock in the insurer's portfolio and preclude such "risky" assets as options and futures, without reference to hedging possibilities, or to the effect of diversification within a portfolio.

[6]Some related issues are discussed by Borch [1981].

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Appendix

(a) The Demand for Insurance is Positively Related to Surplus E

This Appendix is used to illustrate the proposition that the demand for insurance by risk averse consumers is inversely related to the ruin probability as postulated in Section IV b. It is assumed that consumers exhibit diminishing marginal utility of wealth and that insurance prices are actuarially fair both with respect to the expected value of loss and with respect to the ruin probability. The world is simplified to the following states of nature defined according to whether the insured suffers a loss, probability p, and whether the insurer is solvent, probability q.

insured insurer	No Loss	Loss
solvent	1a	2
insolvent	1b	3

probabilities		
States	1	(1-p)
	2	pq
	3	p(1-q)
Total		1.0

It is not necessary to worry further about the subdivision of states 1 since insolvency is irrelevant if the insured does not have a claim. The loss, L, is assumed to be single valued and positive. We assume background wealth A to be independent of the loss state (see Doherty and Schlesinger [1983] for a contrary view). The insured chooses the level of insurance α that maximizes expected utility; the choice being the proportion of the loss, L, to be reimbursed in the loss state. The actuarial premium is equal to the expected loss payment taking account of default risk;

(A1) $P = pqL$

And the expected utility of wealth for the individual is,

(A2) $$EU = (1-p)U[A - \alpha pqL] + pqU[A - \alpha pqL - L + \alpha L]$$

$$+ p(1-q)U[A - \alpha pqL - L]$$

The first order condition to establish a maximum $[dEU/d\alpha = 0]$ may be rearranged to yield

(A3) $$U'_2 = \left[\frac{1-p}{1-pq}\right] U'_1 + \left[\frac{p(1-q)}{1-pq}\right] U'_3$$ where U'_i is the marginal utility of wealth in state i

$$= \pi U'_1 + (1-\pi)U'_3$$

In other words U'_2 is a simple weighted average of U'_1 and U'_2 with each weight lying between zero and one. Since the loss is non zero, the wealth in states 1 and 3 may be ordered

$$w_1 > w_3.$$

This, together with the weighting in equation 3 and the assumption of diminishing marginal utility, implies

(a) if $q = 1$

$[U'_2 = U'_1] \Rightarrow [w_1 = w_2] \Rightarrow [\alpha = 1]$

This is the classic Bernoulli theorem. If a risk averter is offered an actuarially fair (non risky) insurance policy, he (she) will fully insure.

(b) if $0 < q < 1$

$$[U'_1 < U'_2 < U'_3] = [w_1 > w_2 > w_3] = [0 < \alpha < 1]$$

This case is an exception to the Bernoulli theorem which may be added to other exceptions of heirloom insurance (Cook and Graham [1977]) and the random initial wealth case (Doherty and Schlesinger [1983]).

These relationships suggest that the demand for insurance is a negative function of the default probability (1-q). Using the well known risk theory relationship that q is a positive function of surplus E, yields the demand for insurance to be a positive function of E. It is not claimed that this relationship is universal. It is possible to construct a counter example by allowing background wealth A in loss states 2 and 3 to exceed that in state 1 by more than the value of the loss. But such cases would be highly unusual. Therefore, we use this example to suggest the plausibility that the demand function is positive in E.