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Regulation of Insurance Markets

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Abstract

There have been major changes in the way European insurance markets are regulated, and there is still considerable debate about what the form and scope of regulation should be. This article examines the arguments for solvency regulation when consumers are fully informed of the insurer's insolvency risk. It is shown firms always provide enough capital to ensure solvency, unless there are restrictions on the composition of their asset portfolios. The conclusion holds even when competition means that only normal profits can be earned. This suggests that the role of regulation in insurance markets should be confined to providing consumers with information about the default risk of insurers.

Key words: insurance regulation, information, insolvency

1. Introduction

The framework of regulation of the European insurance markets is currently undergoing major changes by the European Commission (EC), which is seeking to "complete the common market" in insurance and in financial services generally. The aim is to facilitate more competition among insurance companies, based in different countries, in each others' home markets. This requires drastic change in regulatory regimes that until now have presented major barriers to such competition.

The EC has adopted a two-step strategy. On the one hand it has harmonized regulations[1] concerning the solvency and financial reporting of insurance companies across all countries of the European Union (EU). The regulations are detailed and differ as between life and nonlife insurance, but broadly speaking they require insurers to carry reserves of liquid capital, over and above normal "technical" or "mathematical" reserves, which are expressed as proportions of premium income and claims expenses. The regulatory agency in the insurer's home country is responsible for enforcing the regulations. The solvency requirements are rules of thumb arrived at by committee decision, and there is some debate about whether they are "adequate" or "excessive." It does not appear that economic analysis has played any part in the determination of these solvency margins. In particular the welfare economics of the arguments for and against such solvency regulations does not seem to have received formal analysis.

The second step in the strategy was to make the regulatory regime to which an insurer is subject that of its home country rather than of the country whose market it is seeking to enter.[2] Because harmonization of the overall regulatory system turned out to be impossible to achieve, the EC's aim was to make it impossible for the regulator in any country to erect barriers to entry of insurers from other EU member states.

A further consequence is the possibility of competition among regulatory regimes. A country will be under pressure to modify its regime if it disadvantages its home insurers in their competition with foreign entrants. Failure to do this could lead companies to relocate or set up subsidiaries in other countries to benefit from competitively more favourable regulatory regimes, as with "flags of convenience" in shipping and "Delaware companies" in the United States. New entrants to the European market will choose to locate in countries with the most favorable regulatory regimes while still having access to the entire European market. In this way de facto harmonization might be achieved in the long run by competition among regulatory systems.

The developments raise a number of interesting economic issues concerning the relationship between regulatory rules on the one hand and competitive interactions among insurance firms on the other. The rationale for the changes would seem to be that firms whose home countries have a light regulatory regime would hold a competitive advantage over those subjects to a tighter regime. Regulation in Britain and France was relatively light, while that in Germany was extremely detailed and centralized, with Italy also tending in this direction.[3] This suggests that British and French insurers could take over the German market or alternatively that regulation in Germany will become as light as that in Britain and the Netherlands.

There has already been a significant loosening of German regulation.[4] The regulator's powers to specify the detailed form of standard contracts in the major areas of insurance, to control premium levels, and to regulate entry have virtually disappeared. The result has been innovation in product specification—for example, lower tariffs for nonsmokers and savings plans involving greater equity participation in life insurance, a finer classification of risk categories in motor insurance, and even the introduction of private unemployment insurance. However, there is so far little sign of general price competition. Habits of collusive price setting established under the centralized regulatory regime persist and have been reinforced by the EC's grant to European insurance trade associations of exemption from antitrust legislation. Premium calculation will still be centralized by actuaries working for the trade association, rather than by the regulatory agency. The latter will still monitor premium levels in the interests of preventing "ruinous competition" and ensuring solvency of insurers. Moreover, the German regulators have succeeded in retaining restrictions on the types of assets German insurers may hold, implying that German regulation is still tighter than that in Britain. The old presumption that, in the insurance market at least, competition is against the public interest seems not to have lost its support.

The normative aspects of insurance market deregulation are still contentious. The standard defense of the detailed German regulation is that it is first and foremost in the consumer interest but also in the longer term interests of insurance companies. Solvency is of prime importance. The buyer of insurance gives up a sum of money against a promise that she will receive a payment in the future if specified random events occur. If the insurer does not provide adequate reserves to fulfill this promise, the consumer is being cheated ex ante, while insolvencies ex post undermine the confidence on which the market is based and thus threaten the long-term interests of the insurers themselves: If there is perception of default risk on the part of consumers one could speak of a "lemons problem," in the sense that uncertainty about product quality—solvency—could drive high-quality firms out of the market, if there were difficulties of signaling high quality. It is further argued that price competition may undermine the solvency of insurers by weakening their financial position.

Proponents of deregulation, on the other hand, argue that the solvency concerns do not require the degree and type of regulation that has existed in Germany and that competition and solvency are perfectly consistent with each other. Empirically, it is argued that the better solvency record in Germany, as compared to, say, Britain, has been bought at much too high a cost in terms of consumer welfare. There is also the strong suspicion of "capture" of regulators by insurers with the implication that regulations exist mainly to benefit insurers and not their customers. The regulatory agency was seen as effectively enforcing a cartel in the interests of the insurance companies.

The EC policy can be viewed as providing some support to the position of the critics of regulation to a limited extent. The process of deregulation subject to uniform constraints on solvency certainly fits with their arguments, though the exemption from antitrust legislation seems to be more consistent with the concern that unrestricted price competition could undermine solvency.[5] The signals from the EC are, not for the first time, conflicting.

The purpose of the present article is to extend the models currently available in the literature that provide an analytical basis for the discussion of solvency, capital requirements, and price competition on insurance markets. We show that solvency regulation is unnecessary if consumers are fully informed about the risks of the insurer's insolvency. This is true in a very strong sense: if consumers correctly perceive the risk of insolvency, then it is not optimal for the monopoly insurer to run the risk of insolvency.[6] It follows that solvency "regulation" could in fact simply be restricted to informing consumers about the true insolvency risk. Solvency regulation is justified only if it is the case that somehow consumers cannot be appropriately informed of, or cannot accurately work out, the risks of insurer insolvency or if the market in the provision of this information somehow fails.[7] Moreover we show that allowing Bertrand price competition does not change this result but strengthens it. In the Nash equilibrium firms will hold enough capital to meet the maximum claims that they may face.

2. Solvency and the insurer

It is usual in the insurance economics literature to consider the insurance market as perfectly competitive.[8] Descriptively there are strong arguments for modeling the insurance market as an oligopoly. However, the appropriate model to use is that of Bertrand where prices are the strategy variables so that, in the absence of product differentiation, even the duopoly outcome is perfectly competitive, and so the difference seems to be inessential.

It is convenient to start with a monopoly model that integrates the firm's decisions over pricing policy and capital provision. We then examine a duopoly with price-setting firms.

We begin by recasting and extending the model in Finsinger and Pauly [1984], which in turn draws heavily on papers by Borch [1981], and Munch and Smallwood [1981]. There is an infinite sequence of time periods. At the beginning of each period the insurer must decide on a level of capital K for the insurance business. He faces a given distribution of claims C, with distribution function $F(C)$ and differentiable density $f(C)$, defined over the interval $[0, C_u]$. For the moment, as in Finsinger and Pauly [1984], we take premium income P also to be exogenous.

P is collected at the beginning of the period and invested along with the capital. We assume initially that the only capital-market asset is a riskless security with gross return $r > 1$. If at the end of the period assets $A \equiv (P + K)r$ are at least enough to meet claims C, then the insurer remains in business and receives a continuation value V that is the expected present value of being in the insurance business at the end of the first period. If claims costs turn out to be greater than assets,[9] the insurer pays out his assets and defaults on the remaining claims, losing the right to the continuation value V. Because of limited liability he does not have to pay out more than A to claimants.

The insurer can always choose to guarantee solvency by putting in enough capital, since we assume that the upper limit C_u on possible claims is finite.[10] The question of interest is: under what circumstances would the insurer choose to stay solvent, thus making regulation unnecessary, and what are the likely effects of competition on his choices?

Define $V(K^*)$ as the continuation value of the firm given that it chooses an optimal K^* in all future periods. Since the model is time invariant, so is the optimal capital input. We assume the insurer is risk neutral and the only cost of capital put into the insurance business is r, the riskless rate of return on the capital market. It follows that his optimal policy is to choose capital in each period to maximize

$$V_0(K) = \frac{1}{r}\int_0^A [r(K+P) - C]\, dF - K + \frac{1}{r}F(r(K+P))V(K^*) \tag{1}$$

subject to $K \in [0, K_u]$, where $K_u = (C_u/r) - P$ is the capital required to ensure no default.

So far nothing beyond differentiability has been assumed for the claims distribution F. Empirically, however, insurance claims distributions typically belong to the class of "increasing failure rate" distributions, with the property that

$$\frac{d}{dC}\left[\frac{1-F(C)}{f(C)}\right] < 0. \tag{2}$$

As Munch and Smallwood [1981] showed, though in a somewhat different model, an implication of this property is that only corner solutions to the insurer's wealth maximization problem are possible: either he chooses $K = 0$, or $K = K_u$. We now show that this result carries over to the present model.

Proposition 1: *Given a claims distribution with the property* (2) *the insurer chooses a corner solution*: $K^* = 0$ *or* $K^* = K_u$.

Proof. Suppose not, so that $K^* \in (0, K_u)$ maximizes $V_0(K)$, which implies

$$V_0'(K^*) = F + fV(K^*) - 1 = 0 \tag{3}$$
$$V_0''(K^*) = V(K^*)f' + f \leq 0. \tag{4}$$

Then (3) implies

$$V(K^*) = (1 - F)/f, \tag{5}$$

while (2) implies

$$f^2 + f'(1 - F) > 0, \tag{6}$$

and so substituting for $V(K^*)$ from (5) into (4) yields a contradiction. □

Note that a solution to the problem does exist, since the objective function is continuous on the compact interval $[0, K_u]$. Which endpoint is optimal is given by the straightforward comparison of the values

$$V(0) = F(rP)\left(P - \frac{\bar{C}_0}{r}\right)r/[r - F(rP)] \tag{7}$$
$$V(K_u) = \left(P - \frac{\bar{C}}{r}\right)r/[r - 1], \tag{8}$$

where $\bar{C}$ is the mean of the claims distribution and $\bar{C}_0 = [F(rP)]^{-1} \int_0^{rP} C dF < \bar{C}$ is the mean of the truncated distribution. As these expressions clearly show, the advantage of not putting up any capital is that the expected present value of claims falls. The disadvantage is the risk of going out of business, $F(rP) < 1$. It does not seem possible to say that one of these endpoints is always better than the other.

However, the results do appear to lend support to the argument that competition is bad for solvency. Competition can be expected to drive premiums down to equal expected claims, in which case the insurer would be indifferent between the two positions. Intuitively, the insurer does not care about the risk of going out of business if in fact future profits of being in the business are zero. Thus in those cases where high premiums might induce the insurer to choose K_u, competition could lead to greater insolvency risk. However, we show below that this argument does not survive the appropriate formal modeling of price competition.

There are two major limitations of this model of the insurance firm that could make any policy conclusions derived from it of limited relevance. The first is that the only assets available on the market are safe assets. We need to allow for the interaction between the risks associated with insurers' asset portfolios and those associated with their insurance activities. The second limitation is the exogeneity of the premium income. This is not simply a matter of allowing the monopolist to choose the premium or volume of insurance sold by maximizing profit with respect to a given demand function. It also implies the assumption that *the demand for insurance is independent of the solvency risk of the insurer*. This is a central issue that has to be considered explicitly.

The first of these limitations, but not the second, is dealt with by MacMinn and Witt [1987]. They assume the insurer can invest in a risky as well as a riskless asset, is risk-averse, and faces a given demand function for insurance with respect to which it maximizes expected utility. The main purpose of the article is to consider the effects of various kinds of regulatory constraints on the decisions of the insurer. In this it makes a valuable contribution. The article, assumes, however, that the only source of investment funds is premium income—that is, $K = 0$. Consequently, the article cannot shed light on the interesting question of whether the "corner solution" property disappears when risky assets are introduced. Finsinger and Pauly [1984] showed that the introduction of a positive marginal cost of raising insurance company capital may have this result, in cases where the insurer would otherwise choose K_u, since at an interior point the marginal benefit to the insurer of increasing K may fall below this cost. However, the reason for the existence of this cost is not clear, and it would be interesting to see if the same result can be produced by the more plausible step of introducing risky assets.

MacMinn and Witt [1987] assume that the demand for insurance is independent of the insolvency risk. Buyers of insurance are assumed to behave as if they believed that insolvency was impossible. We regard this assumption as the single most important limitation of the existing literature, and so the remainder of this article is concerned with tackling it.

3. Consumer perceptions and insolvency

3.1. Riskless assets

We begin by introducing an insurance market into the model in almost the simplest possible way, short of just assuming a given demand function. We assume there is just one insurance buyer with loss distribution $F(C)$ and utility function $u(.)$, with $u' > 0$, $u'' < 0$. In the absence of insurance she obtains an expected utility

$$\bar{u}_0 \equiv \int_0^{C_u} u(y - C)\, dF \tag{9}$$

with y given. The insurer makes a take-it-or-leave-it offer of an insurance contract giving "full cover" of loss at a premium P. However, the buyer is able to observe the choice of K by the insurer, and so the premium must satisfy her reservation constraint

$$\int_0^{A} u(y - P)\, dF + \int_A^{C_u} u(y - C - P + A)\, dF \geq \bar{u}_0. \tag{10}$$

In words, as long as the insurer's assets cover claims the insured has a certain income, but if her claim exceeds the insurer's assets (that is, he is insolvent), she receives only the amount of these assets, and so she is left with a residual risk. She determines her willingness to pay accordingly.

Let P_0 denote the premium that satisfies (10) as an equality when $A = P_0$—that is, $K = 0$. Likewise P_u is this premium defined by $u(y - P_u) = \bar{u}_0$ when there is no default risk. The amount of capital that leads to zero default risk is $K_u = C_u/r - P_u$.

Proposition 2: *When the insurance buyer is fully informed about the firm's choice of capital, the insurer's expected value is larger at P_u, K_u than at P_0 and $K = 0$.*

Proof. We have to show

$$\frac{1}{r-1}\int_0^{C_u}(rP_u - C)\,dF > \frac{1}{r - F(rP_0)}\int_0^{rP_0}(rP_0 - C)\,dF, \tag{11}$$

which since $r - 1 < r - F$, is implied by

$$rP_u - \int_0^{C_u} C\,dF > F(rP_0)rP_0 - \int_0^{rP_0} C\,dF$$

or

$$rP_u > F(rP_0)rP_0 + \int_{rP_0}^{C_u} C\,dF. \tag{12}$$

Define $\tilde{P}$ to satisfy

$$u(y_0 - \tilde{P}) = \frac{1}{1 - F(rP_0)}\int_{rP_0}^{C_u} u(y_0 - C)\,dF. \tag{13}$$

By Jensen's inequality

$$\tilde{P} > \frac{1}{1 - F(rP_0)}\int_{rP_0}^{C_u} C\,dF$$

or

$$[1 - F(rP_0)]\tilde{P} > \int_{rP_0}^{C_u} C\,dF. \tag{14}$$

From (13) we have

$$u(y_0 - P_u) = F(rP_0)u(y_0 - P_0) + [1 - F(rP_0)]u(y_0 - \tilde{P}) \tag{15}$$

and again Jensen's inequality gives

$$P_u > F(rP_0)P_0 + [1 - F(rP_0)]\tilde{P}, \tag{16}$$

implying, using (14),

$$rP_u > F(rP_0)rP_0 + r\int_{rP_0}^{C_u} C dF > F(rP_0)rP_0 + \int_{rP_0}^{C_u} C dF \tag{17}$$

as required. □

A similar result can be proved for any $K < K_u$. The intuition is that the consumer would always be prepared to pay more than the fair premium to insure against the insurer's insolvency, and so it pays the insurer to sell this to her, which in turn implies he must put up enough capital to remain solvent.

The case of a single consumer is of course rather special but serves to bring out the main point. We can generalize quite easily. Thus, suppose there are N consumers, each with endowed wealth y and faced with an identical and independent risk of loss $L < y$ with probability p. Any risk of default is fully and correctly perceived by the buyers. In the case of default it is necessary to make some assumption about how insurance claimants would be rationed in the event that the value of claims exceeds the insurer's end-of-period assets. Thus we assume:

1. Insurance contracts are for full coverage.
2. There is random rationing in the following sense: if a consumer has a claim and total claims exceed assets then with a probability equal to the ratio of assets to claims each claimant will receive the indemnity in full, otherwise she receives nothing.

The first of these assumptions is made for simplicity; the second seems quite reasonable. We can imagine that losses hit consumers randomly throughout the period, are reported as they occur, and then payouts are made at the end of the period in the order in which losses were reported, until assets are exhausted or all claims are met.[11] Given a full cover insurance policy $\{P, I\}$, where P is the premium and $I = L$ the indemnity, the representative individual buys insurance if and only if the participation constraint

$$\begin{aligned}&(1-p)u(y-P) + p\{(1-\pi)u(y-P)\\&\quad + \pi[(1-\theta)u(y-P) + \theta u(y-P-L)]\} \geq \bar{u}_0\end{aligned}$$

or

$$(1-q)u(y-P) + qu(y-P-L) \geq \bar{u}_0 \tag{18}$$

holds. Here, $\bar{u}_0$ has the same meaning as before, π is the probability that the insurer is insolvent given the insured suffers the loss, and θ is the probability that she receives nothing given she has a claim and the insurer is insolvent. In effect, then, there are still only 2 "income events" for the consumer—one in which she either has no loss or receives full indemnity, and the other in which she bears the full loss. In both events, of course, she has paid the premium. The probability of the latter event is $q = p\pi\theta$, and that of the former is

$1 - q$. This probability can be written as follows. Suppose the insurer chooses to meet a given number $n < N$ of claims. Then

$$q = p \sum_{m=n-1}^{N-1} \binom{N-1}{m} p^m (1-p)^{N-1-m} \left[1 - \frac{n}{m+1}\right] \tag{19}$$

It is then straightforward to prove the equivalent result to Proposition 2 for this model. It simply has to be noted that if the insurer has less capital than $K_m = N(L - rP_m)/r$, where P_m is the largest premium that can satisfy (18) with $q = 0$, then $q > 0$, and the expected cost of claims is $N(p - q)L$, since Nq is the expected number of claimants that will receive nothing. Then we have

Proposition 3: *If buyers know the probability q that they will not be compensated, the insurer maximises his expected value by choosing a capital K_m so that there is no default risk and q is zero.*

Proof. We have to show that

$$\frac{1}{r-1} N(rP_m - pL) > \frac{1}{r-(1-d)} N(rP_q - (p-q)L), \tag{20}$$

where d is the probability that the firm defaults and P_q is the largest value of P that can satisfy (18) for the given value of q. Since $r - 1 < r - (1 - d)$, it suffices to show that

$$rP_m \geq rP_q + qL. \tag{21}$$

Since the buyer's reservation constraint is satisfied as an equality, we have

$$u(y - P_m) = (1-q)u(y - P_q) + qu(y - P_q - L), \tag{22}$$

and so by Jensen's inequality we have

$$P_m > (1-q)P_q + q(P_q + L), \tag{23}$$

which implies

$$rP_m > rP_q + rqL > rP_q + qL \tag{24}$$

as required. □

As for Proposition 2, the intuition is that the insured would always be prepared to pay more than the fair premium to insure against the insurer's insolvency, the insurer finds it profitable to sell her this, but this requires him to put up enough capital so that he remains solvent.

These simple but far-reaching results suggest that the only purpose of regulation in insurance markets should be to inform consumers of insolvency risks. That is, an insurer would announce his capital, and the regulator would also know the parameters of the claims distribution. The regulator would then announce the default probability for consumers, who would then make their insurance decisions. The above argument then suggests that in fact the capital will be sufficient to ensure no risk of insolvency. It could also be argued that the present European system of solvency regulation in fact is a simpler way of achieving the same result: the level of capital K is specified for insurers, and consumers can then take their insurance decision consistent with the fact that there is a zero probability of default. The danger is, as we see in the German case, that regulation rather than information dissemination lends itself more readily to capture and extension of regulatory powers to effective enforcement of a cartel.

3.2. Risky assets

To conclude this section we extend this point somewhat. A feature of tightly regulated insurance markets is the imposition of constraints on the composition of the insurer's asset portfolio. We now show that this in itself can create the need for solvency regulation, in the sense that without the constraints there is no insolvency risk but imposing them leads the insurer to choose a smaller capital than K_m and thus run the risk of insolvency, even though this is perceived by buyers and results in a lower premium. This is a Pareto inefficiency, since the insurer is worse off and insurance buyers no better off: they continue to receive their reservation expected utility. The inefficiency is not removed by then requiring the insurer to put K_m into the insurance business.

The intuition is straightforward. In the absence of constraints on portfolio composition it is effectively costless to put capital in the insurance business when there is no risk of insolvency. Exactly the same portfolio can be chosen as would be the case if the capital were invested outside the insurance business. However, constraints on the portfolio of the insurer create marginal opportunity costs of capital invested in insurance that would not otherwise exist, and this could lead to an optimum at an interior point of the interval $[0, K_m]$.

Suppose there are two types of assets, a riskless asset with gross return r and a risky asset with expected gross return $\bar{v} > r$ and *minimum* gross return $v_0 > 0$. This latter assumption is important because it ensures that there is always a finite amount of capital that can be invested in the insurance business to ensure solvency even when entirely invested in the risky asset.[12] The risk-neutral insurer would put all his capital into the risky asset and so would require

$$K_m = \frac{C_m}{v_0} - NP_m \tag{25}$$

to ensure solvency, where C_m is the upper bound on total claims and P_m is the largest premium each of the N fully informed buyers would pay for full cover with no risk of insolvency. The earlier results imply K_m is optimal in the absence of portfolio restrictions. However, suppose a regulator requires that a proportion $1 \geq \lambda > 0$ of any capital put into the insurance business must be invested in the riskless asset. Then we have

Proposition 4: *On the given assumptions the insurer will choose $K^* < K_m$ in the presence of portfolio constraints.*

Proof. The opportunity cost of capital put into the insurance business is $\bar{v}K$, while the expected return on this capital is $r\lambda = [\lambda r + (1-\lambda)\bar{v}]K$. It follows that the net opportunity cost of a unit of capital invested in the insurance business is $\beta = \lambda(\bar{v} - r) > 0$. At $K = K_m - \varepsilon$ the expected value of the insurer is

$$V(K_m - \varepsilon) = \frac{N[r\lambda P_q - (p-q)L]}{\bar{v} - (1-d)} - \frac{\beta(K_m - \varepsilon)}{\bar{v} - (1-d)}.$$

We know from Proposition 3 that the first term is maximized at $\varepsilon = 0$ and so

$$\left.\frac{dV(K_m - \varepsilon)}{d\varepsilon}\right|_{\varepsilon=0} = \frac{\beta[(\bar{v}-1) + K_m d\varepsilon]}{(\bar{v}-1)^2},$$

which is positive since default risk is increasing in ε. □

4. Price competition and solvency

The contention of the advocates of extensive regulation is that price competition undermines solvency. This could perhaps be lent support by the results of the first model considered, in Section 2, where it appeared that if there was a zero profit from the insurance business there would be no incentive to avoid bankruptcy. We analyze the issue more explicitly in a model of Bertrand competition, which seems the most appropriate one for insurance markets since insurers are essentially price-setters. As we would expect, with identical firms and no transactions costs, each firm sets the fair premium at a market equilibrium.

More to the point, there is no bankruptcy risk in equilibrium. Each firm puts enough capital into the insurance business to cover the maximum total claims in the entire market. This is costless, as long as there are no restrictions on insurance company asset portfolios. The intuition is straightforward. The usual Bertrand logic says that if a firm's price is above marginal cost (here, the fair premium), the other can profitably undercut it by shading price slightly and capturing the entire market. In the present model that can happen only if indeed the firm cutting price has enough capital to ensure a zero rationing probability if it obtains the entire market. In other words, having this amount of capital is required to make the price competition credible. Price competition could hardly be more cut-throat than in this market, but it does not undermine solvency because firms back it up with sufficient capital reserves.

We use the model of the previous section, with N insurance buyers each faced with the risk of a loss L with probability p, but now with two firms (this could easily be generalized). To simplify, we assume here that $r = 1$. This is not essential in that the result holds for $r > 1$, but because we have assumed that insurance firms' only costs are their payments to insureds, $r > 1$ would yield an equilibrium insurance premium, which is less than the expected loss per insured.

The firms simultaneously announce a premium P and an amount of capital K. If premiums and insolvency risk are identical each firm receives half the market, while with no insolvency risk the firm with a lower premium would take the entire market. We now define

$$K_m = N(1-p)L \tag{26}$$

as the amount of capital an insurer would require to supply the entire market with no solvency risk, at the fair premium pL. Then we have

Proposition 5: *In the Nash equilibrium each insurer announces a premium pL and a capital $K \geq K_m$.*

Proof. (i) Neither firm would choose a premium below pL, since this implies expected losses.

(ii) Suppose one firm sets a premium strictly above pL, with arbitrary capital. The other can gain the entire market at some premium just below this, and with at least the amount of capital. Moreover, as we saw in the previous section (Proposition 3), the highest expected profit can be made when the default probability is zero. Thus a firm's best response to a premium above pL is to choose capital $K \geq K_m$ and offer a slightly lower premium. The best response to this in turn is to choose capital $K \geq K_m$ and offer a slightly lower premium, and so on. Thus no premium above pL can be an equilibrium.

(iii) Suppose both firms offer the premium pL. It cannot be an equilibrium to have $K < K_m$. If $K < \frac{1}{2}K_m$, buyers face a default risk, and we know that cannot be optimal for the insurer. If $\frac{1}{2}K_m \leq K < K_m$, one firm could raise the premium slightly without losing all its customers and so make an expected profit. The reason is that if all its consumers switched to the other insurer, there would be a default risk, while they would be compensated for sure if they stayed with the original firm. Since their willingness to pay is higher in the absence of default risk, the conclusion follows. □

Competition leads not only to a Pareto-efficient equilibrium but one in which there is zero probability of insolvency. This suggests that the observation of insolvencies in markets characterized by competition, such as in the United Kingdom, is more likely to be due to the sorts of factors that cause bankruptcies in all markets—for example, excessively high cost levels—rather than failure to provide capital.

5. Conclusions

Though there are local variations reflecting past history, we could say that regulation in European insurance markets has made a significant move toward regulation of solvency alone. While more extensive regulation of the German sort is hard to justify and probably can be explained by the theory of capture, the inevitable asymmetry of information between insurers and insured may justify some kind of solvency supervision.[13] If consumers naively believe that the insurer will always be solvent then the analysis of Section 2 showed that it could be optimal for the insurer not to put up any capital and run the risk of insolvency.[14]

However, if consumers are fully informed of insolvency risk, and there are no restrictions on the insurer's asset portfolio, then the insurer will always find it profitable to reduce this risk to zero. This holds true when price competition leads to the elimination of all supernormal profit. In these circumstances the purpose of regulation should be simply that of providing consumers with the required information, and regulatory agencies should be restricted to this role.

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Notes

1. For a good, concise survey and discussion of these regulations, see Konrath [1966].
2. On the other hand, the relevant law, including contract law, is that of the country in which the insurance business is done.
3. For informative accounts of European regulatory systems prior to the EC measures, see Finsinger and Pauly [1986], Finsinger, Hammond, and Tapp [1985], and for a detailed critique of regulation in Germany, Finsinger [1983]. For more general analysis of regulation on insurance markets, see Briys and de Varenne [1994], Doherty and Garven [1986], Finsinger and Pauly [1984], and Joskow [1973]. Two important papers that analyze insurance market regulation and model simultaneously the financial decisions of the firm and premium determination are MacMinn and Witt [1987] and Munch and Smallwood [1981].
4. The assertions made in this paragraph are based on Hohlfeld [1996]. The author was at the time head of the German regulatory authority.
5. Ostensibly the argument is that it is necessary to pool claims data in order to calculate loss probabilities more accurately, a long-standing and well-refuted claim of the German regulatory authorities.
6. An important contribution in this area, Doherty and Schlesinger [1990], analyzes the individual's insurance demand in the presence of insurer default risk. A number of interesting results are derived that show that the standard results on insurance demand do not carry over to this case. However, the decision of the insurer is not considered. Here we are arguing that if the consumer is fully informed of the default risk, as Doherty/Schlesinger assume, it is *optimal for the insurer* not to default, and so the problem essentially disappears. Although for simplicity here we assume rather than derive the demand for insurance under positive default probability, this basic result also carries over to the more general case.
7. It is certainly reasonable to argue that regulatory agencies may have greater coercive powers to obtain information than private agencies, as well as better sanctions to deal with adverse selection problems.
8. For interesting exceptions, see Polborn [1998], and Schlesinger and Schulenburg [1991].
9. Here, as elsewhere in this article, we ignore the possibility of reinsurance. We also ignore the fact that insurance companies can be traded on stock markets. Both features would complicate our analysis, and we leave them for future work.
10. This assumption represents a modification of the Finsinger-Pauly model, as does the assumption of a rate of return $r > 1$ and the interpretation of the variable V. Finsinger and Pauly, in common with standard actuarial practice, treat the claims distribution as unbounded above. In effect, then, solvency can never be guaranteed. It seems to us both more realistic and interesting to take the claims distribution as bounded above so that solvency could always in principle be achieved. An insurer always has a finite number of customers with an upper bound on the loss under any contract.

11. Notice that our assumption avoids the complications that arise because payouts are made as claims are made, rather than at the end of the period as we assume. Without the assumption bankruptcy can occur during the period, leaving some insureds who do not have an accident with no protection for the rest of the period and some insureds will have had an accident but not had their claim processed.
12. Some risky assets may lead to a loss of more than the sum invested—for example, derivatives. In this case, consumers need to know the portfolio composition as well as the total reserves.
13. Of course, it could be argued that this could also be left to "the market." Private rating agencies would find it profitable to perform this function, just as with quality assessment of other kinds of goods. In fact, already in Germany since deregulation a number of "rating agencies" have set up business. Why be dogmatic? If it appears that the informational function these agencies can fulfill makes a regulatory agency redundant, then regulation should cease altogether.
14. A referee has suggested an interesting further justification for regulation as a substitute for the insurer's inability to commit to future portfolio composition when they write insurance contracts. When consumers are aware of such lack of commitment, some Pareto-improving insurance contracts may not written.

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