Adverse Selection, Aggregate Uncertainty, and the Role for Mutual Insurance Companies

Smith, Bruce D. and Michael J. Stutzer

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Bruce D. Smith
University of Western Ontario and
Rochester Center for Economic Research

Michael J. Stutzer
Federal Reserve Bank of Minneapolis

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I. Introduction

At this point the theoretical and empirical literature about insurance contracts is large and diverse (and sufficiently so that we will not attempt to make a list of major contributions). However in all of this literature there is virtually no mention made of the fact that large parts of the insurance industry are populated by mutual insurance firms, with these firms playing a major role in life and casualty insurance, for instance, as well as other areas of the industry. Given that mutual forms of organization are also common in other activities, such as lending,[1] it seems important to understand why such forms of organization arise.

We take the distinguishing feature of mutual insurance contracts to be what Rothschild and Stiglitz [1976, p. 646] described as "the peculiar provision...that the effective premium [on such contracts] is not determined until the end of the period,..." i.e., until the aggregate experience of those insured is known. Or, put differently, we view mutual insurance companies as a form of organization in which aggregate risks are shared between the insurer and the insured. In this paper we develop a model in which mutual insurance companies arise endogenously. Moreover, such insurance companies co-exist in insurance markets with investor owned (or "non-mutual") insurance firms, replicating an important unexplained aspect of observed behavior in the insurance (and other) industries.

The model we develop to explain the existence of mutual insurance firms (and their co-existence with non-mutual firms) is a simple variant of the adverse selection model of Rothschild and Stiglitz [1976] and Wilson [1977]. In particular, we consider an environment which is identical to that of those authors, with the single addition being that insurance contracts are written before the realization of some random variable, which affects the accident probabilities of the entire insured population. Thus there will be a set of agents of different types, indexed by i, who have different probabilities of not filing a claim. These probabilities, $p_i(s)$, depend on the realization of a random variable s, which is drawn after insurance contracts are written. Under a simple non-degeneracy condition on the values $p_i(s)$, and under the assumption of risk neutral insurers, we show that the insurance industry will consist of two kinds of firms. One kind, which will insure "high-risk agents," will consist of non-mutual insurers, or in other words, will offer insurance contracts where payments do not depend on the realization of s. (That is, premiums are determined before the "end of the period.") The other type of insurer will be a mutual insurer, so insurance contracts depend on s. "Low risk" agents will purchase contracts from mutual insurers. Thus the organization of an insurance firm as a mutual or as an investor owned enterprise functions as a sorting device. Low risk insurance purchasers signal their type by being willing to share in aggregate risk with their insurer.

In addition to offering an explanation for why mutual and non-mutual forms of organization co-exist, we also view this paper as part of a literature that has explored the results of fairly basic alterations in adverse selection environments. For instance, Judd [1984] and Riley [1985] examine the implications of agents having alternate opportunities in such environments. Jaynes [1978] and Eichenbaum and Peled [1987] consider altering assumptions about what is observable. Here we introduce aggregate uncertainty, and consider its consequences. In other contexts, such as a loan market context, our results can be reinterpreted as predicting the co-existence of state contingent and uncontingent debt.[2]

II. The Model

We consider a simple variation of the insurance environment discussed by Rothschild and Stiglitz (1976). There are three groups of agents. One group is a set (with a fixed number of members that exceeds one) of potential sellers of insurance. These agents will be called insurance firms. Insurance firms are risk neutral, and in addition are assumed to have an endowment of the single consumption good which is large enough so that insurance firms can conceivably assume all aggregate risk.[3]

In addition to insurance firms, there is a continuum of risk averse agents, who can be divided into two types. All of these agents have identical utility functions $U(c)$ with $U' > 0$, $U'' < 0$ $\forall c \in R_+$. Each agent receives a random endowment e of the consumption good drawn from the two element set $\{e_1,e_2\}$; $e_1 > e_2 > 0$. An agent whose endowment is e_1 has not suffered a loss, while obtaining the endowment e_2 constitutes "a loss".

There is an aggregate random variable s, which is also drawn from a two element set; $s \in \{1,2\}$. s is realized after insurance contracts are entered into (thus giving insurance firms an opportunity to insure against aggregate as well as individual specific risk). Let $\pi(s)$ denote the probability of state s.

Further, let i index agents' "types". Given the realization of s, a type i agent has a probability $p_i(s)$ of receiving the endowment e_1, or a probability $1-p_i(s)$ of suffering a loss. We let $p_2(s) > p_1(s)$ hold for all s, so that type 2 agents are the "low risk" group. We also let $p_i(2) > p_i(1)$ hold $\forall i$, so that state 2 is unambiguously the "good" aggregate state. Agents know their types before purchasing insurance contracts (and hence before s is known). A fraction θ of all insured agents are of type one. Conditional on s, endowment realizations are independent across agents, so the fraction of type i agents receiving e_1 is $p_i(s)$.[4] Finally, it is assumed that either

$$(1) \quad p_1(1)/p_2(1) \neq p_1(2)/p_2(2)$$

or

$$(2) \quad [1 - p_1(1)]/[1 - p_2(1)] \neq [1 - p_1(2)]/[1 - p_2(2)]$$

holds, or both.[5]

A. <u>Equilibrium</u>

Let $c_j^i(s)$ denote the consumption of a type i agent who receives endowment e_j in state s. Then insurance firms offer contracts which consist of consumption schedules $c_j^i(s)$; i,j,s = 1,2. As before, and as in Rothschild and Stiglitz, each insurance firm is restricted to the offer of a single consumption schedule, so that "cross-subsidization" is ruled out.[6]

Given an offered consumption schedule $c_j^i(s)$, an insurance firm attracting type i agents earns the ex post profit

$$(3) \quad \psi_i(s) = p_i(s)[e_1 - c_1^i(s)] + [1-p_i(s)][e_2 - c_2^i(s)]; \; i=1,2.$$

The objective of each firm is to maximize expected profits, given the offers of other firms. Expected profits associated with any contract offer are $\Sigma_s \pi(s)\psi_i(s)$. Finally, contract offers must be incentive compatible in the presence of other announced contracts. Incentive compatibility here requires that

$$(4)\quad \sum_s \pi(s)p_1(s)U[c_1^1(s)] + \sum_s \pi(s)[1-p_1(s)]U[c_2^1(s)]$$

$$\geq \sum_s \pi(s)p_1(s)U[c_1^2(s)] + \sum_s \pi(s)[1-p_1(s)]U[c_2^2(s)]$$

$$(5)\quad \sum_s \pi(s)p_2(s)U[c_1^2(s)] + \sum_s \pi(s)[1-p_2(s)]U[c_2^2(s)]$$

$$\geq \sum_s \pi(s)p_2(s)U[c_1^1(s)] + \sum_s \pi(s)[1-p_2(s)]U[c_2^1(s)].$$

As usual, a Nash equilibrium is a set of announced insurance contracts such that, given these announcements, no firm has an incentive to offer an alternative insurance contract.

III. <u>The Rothschild-Stiglitz Equilibrium</u>

As a point of reference, this section constructs the analogue of the Rothschild-Stiglitz equilibrium for this economy. Specifically, for the purposes of this section, it is assumed that firms are precluded from offering insurance contracts contingent on s or, in other words, announced contracts must obey $c_j^i(1)=c_j^i(2)\ \forall\ i,j$. This restriction will essentially reproduce the Rothschild-Stiglitz equilibrium allocation of resources.

Under the restriction on announced contracts, any equilibrium contract offer must have the properties derived by Rothschild and Stiglitz: (i) self-selection of types by contract selected must occur, (ii) all offered contracts must earn zero expected profits, and (iii) all contracts must be maximal for the agents selecting them among the set of contracts that earn nonnegative expected profits and that are consistent with self-selection. The arguments to this effect are identical to those given by Rothschild and Stiglitz, and are therefore omitted here.

Equilibrium contracts are now easily derived. To begin, define $\bar{p}_i = \sum_s \pi(s)p_i(s)$; $i=1,2$. In addition, noting that (as in Rothschild and Stiglitz) incentive constraints do not bind on the determination of (c_1^1,c_2^1), this contract must be maximal for type 1 (high-risk) agents among the set of contracts that earn nonnegative expected profits. Hence, in equilibrium (c_1^1,c_2^1) must solve the problem

$$\max \bar{p}_1 U(c_1^1) + (1-\bar{p}_1)U(c_2^1)$$

subject to

$$\text{(6)} \quad \bar{p}_1(e_1-c_1^1) + (1-\bar{p}_1)(e_2-c_2^1) = 0.$$

The solution to this problem is characterized by complete insurance, i.e.,

$$c_1^1 = c_2^1 = \bar{p}_1 e_1 + (1-\bar{p}_1)e_2 \equiv c^*.$$

Determination of (c_1^2,c_2^2) involves finding the maximal contract for type 2 agents that earns nonnegative expected profits, and that is incentive compatible in the presence of the contract offer $(c_1^1,c_2^1) = (c^*,c^*)$. In equilibrium (c_1^2,c_2^2) must solve the problem

$$\max \bar{p}_2 U(c_1^2) + (1-\bar{p}_2)U(c_2^2)$$

subject to

$$(7)\quad \bar{p}_1 U(c_1^2) + (1-\bar{p}_1)U(c_2^2) \le U(c^*)$$

$$(8)\quad \bar{p}_2(e_1-c_1^2) + (1-\bar{p}_2)(e_2-c_2^2) = 0.$$

As in Rothschild-Stiglitz, (7) must be binding in equilibrium. This equation and (8) then determine a unique consumption pair $(\hat{c}_1^2,\hat{c}_2^2)$.

The contract offers $(c_1^1,c_2^1) = (c^*,c^*)$ and $(c_1^2,c_2^2) = (\hat{c}_1^2,\hat{c}_2^2)$ are exactly the Rothschild-Stiglitz contracts with the expected loss probabilities $\bar{p}_i = \Sigma_s \pi(s)p_i(s)$ playing the role of the Rothschild-Stiglitz probabilities. Finally, existence issues here are exactly as in Rothschild-Stiglitz, so that existence of equilibrium can be guaranteed by appropriate choice of the fraction θ of type 1 agents.

IV. An Equilibrium with Mutual Insurance Firms

We now investigate the properties of equilibrium contracts with the restrictions $c_j^i(1) = c_j^i(2)$ relaxed. As in the previous section, it is the case that any set of equilibrium contract offers must have the following properties: (i) self-selection of types by contract selected occurs, (ii) all offered contracts earn zero expected profits, and (iii) all offered contracts must be maximal for the agents selecting them among the set of contracts that earn non-negative expected profits and that result in self-selection occuring.[7] We now proceed to characterize equilibrium contracts.

To begin, consider the contracts obtained by type 1 agents, specifying values $c_j^1(s)$. Incentive constraints cannot bind on the choice of type 1 contracts, as will be apparent. Then $c_j^1(s)$; j,s=1,2, solves the problem

$$\max \sum_s \pi(s)p_1(s)U[c_1^1(s)] + \sum_s \pi(s)[1-p_1(s)]U[c_2^1(s)]$$

subject to

$$(9) \quad \sum_s \pi(s)p_1(s)[e_1-c_1^1(s)] + \sum_s \pi(s)[1-p_1(s)][e_2-c_2^1(s)] = 0.$$

Letting λ denote the Lagrange multiplier associated with the constraint (9), the first order conditions for this problem are

$$(10) \quad \pi(s)p_1(s)U'[c_1^1(s)] = \lambda\pi(s)p_1(s);\ s=1,2$$

$$(11) \quad \pi(s)[1-p_1(s)]U'[c_2^1(s)] = \lambda\pi(s)[1-p_1(s)];\ s=1,2.$$

Then, as is apparent from (10) and (11), $c_j^1(s)$ is constant across j and s, so $c_j^1(s) = c^* \ \forall\ j,s$. Thus type 1 agents do not share aggregate risk with their insurers, i.e., type 1 agents purchase contracts from firms that are <u>not</u> mutual insurance firms. These contracts provide complete insurance against both individual specific and aggregate risks.

It remains to derive type 2 contracts. If an equilibrium exists, the equilibrium contract obtained by type 2 agents must be maximal for them among the set of contracts earning zero expected profits, and that satisfy (4) given that $c_j^1(s) = c^* \ \forall j,s$. Thus the values $c_j^2(s)$ must solve the problem

$$\max \sum_s \pi(s)p_2(s)U[c_1^2(s)] + \sum_s \pi(s)[1-p_2(s)]U[c_2^2(s)]$$

subject to

$$(12)\quad U(c^*) = \sum_s \pi(s)p_1(s)U[c_1^2(s)] + \sum_s \pi(s)[1-p_1(s)]U[c_2^2(s)]$$

$$(13)\quad \sum_s \pi(s)p_2(s)[e_1-c_1^2(s)] + \sum_s \pi(s)[1-p_2(s)][e_2-c_2^2(s)] = 0.$$

The first order conditions for this problem are

$$(14)\quad [p_2(s)-\mu p_1(s)]U'[c_1^2(s)] - \eta p_2(s) = 0;\ s=1,2$$

$$(15)\quad \{1-p_2(s)-\mu[1-p_1(s)]\}U'[c_2^2(s)] - \eta[1-p_2(s)] = 0;\ s=1,2.$$

where μ and η are the Lagrange multipliers associated with (12) and (13) respectively.

The contract that satisfies (12) - (15) is characterized more fully below. However, we may immediately note that $c_j^2(1) \neq c_j^2(2)$ for at least one j. To see this, suppose that $c_j^2(1) = c_j^2(2)$; $j=1,2$. Then (14) and (15) imply that

$$(16)\quad \frac{p_2(1) - \mu p_1(1)}{p_2(2) - \mu p_1(2)} = \frac{p_2(1)}{p_2(2)}$$

and

$$(17)\quad \frac{1-p_2(1) - \mu[1-p_1(1)]}{1-p_2(2) - \mu[1-p_1(2)]} = \frac{1-p_2(1)}{1-p_2(2)}.$$

But (16) and (17) imply that (since $\mu > 0$ must hold)

$p_1(1)/p_2(1) = p_1(2)/p_2(2)$ and $[1-p_1(1)]/[1-p_2(1)] = [1-p_1(2)]/[1-p_2(2)]$, contrary to (1) and (2). Thus $c_j^2(1) \neq c_j^2(2)$ for at least one j. In any equilibrium, type 2 agents must share aggregate risks with their insurers.

Any equilibrium, then, has the property that some agents (type 1 agents) are insured by investor owned insurance firms, while other agents (type 2 agents) recieve insurance contracts where their payments are not determined until the aggregate experience of their insurer is known. Thus mutual insurance firms must co-exist with investor owned firms in equilibrium.

A. Existence of Equilibrium

We would like to have something to say about existence issues in the presence of state contingent insurance contracts. However, we have been unable to obtain any interesting results on this question. In particular, it is not obvious whether permitting state contingent contracts makes existence of an equilibrium easier or more difficult to obtain here. The introduction of state contingent insurance contracts improves the welfare of type 2 agents relative to section III. However, the pooling contract most preferrred by type 2 agents also has $c_j(1) \neq c_j(2)$ for at least one j. Thus the introduction of state contingencies into insurance contracts also increases the expected utility obtainable by type 2 agents under pooling. We have not been able to determine which expected utility level increases more. However, we might observe that in a loan market version of the model presented here, but in which all agents are risk neutral, if the section III equilibrium exists, then the section IV equilibrium exists as well.[8] We might also observe that if θ is chosen sufficiently large, an equilibrium will continue to exist, as in Section III.

B. **Properties of Equilibrium Contracts**

When an equilibrium exists, then, the equilibrium has the feature that agents are sorted in part by the type of firm from which they purchase insurance. High risk agents receive complete insurance (including against aggregate uncertainty) from investor owned insurance firms, while low risk agents signal their type by purchasing insurance from mutual insurance firms. In doing so, these agents signal their type by expressing a willingness to share risks associated with aggregate uncertainty with their insurers.

It is possible to characterize further how this signalling occurs. Using (14) for s=1,2, it is immediate that $c_1^2(2) \geq (<)\ c_1^2(1)$ iff

$$\frac{p_1(1)}{p_2(1)} \geq (<) \frac{p_1(2)}{p_2(2)}. \tag{18}$$

Similarly, using (15) for s=1,2, it is immediate that $c_2^2(2) \geq (<)\ c_2^2(1)$ iff

$$\frac{1-p_1(1)}{1-p_2(1)} \geq (<) \frac{1-p_1(2)}{1-p_2(2)} \tag{19}$$

Since $p_2(s) > p_1(s)$; s=1,2 it is possible to show that $c_1^2(2) \geq c_1^2(1)$ and $c_2^2(2) \geq c_1^2(2)$ never hold simultaneously. (By (1) and (2), $c_j^2(1) \neq c_j^2(2)$ holds for some j.) All other combinations are possible, however. We now say a word about when each case occurs.

Case 1. $p_1(1)/p_2(1) > p_1(2)/p_2(2)$ and $[1-p_1(1)]/[1-p_2(1)] < [1-p_1(2)]/[1-p_2(2)]$. In this case $c_1^2(2) > c_1^2(1)$ and $c_2^2(1) > c_2^2(2)$ hold, so that in this case low risk agents receive closer to complete insurance in the "bad" aggregate state (s=1) than in the "good" aggregate state. Intuitively this may be thought of as follows. $1 > p_1(1)/p_2(1) > p_1(2)/p_2(2)$ implies that the probability of <u>not</u> filing a claim for type 1 agents is higher relative to that for type 2 agents when s=1 than when s=2. Hence setting $c_1^2(2) > c_1^2(1)$ makes the cost of insurance highest (when purchasing from a mutual firm) when type 1 and 2 agents are most alike in terms of probabilities of not filing claims. Similarly $1 < [1-p_1(1)]/[1-p_2(1)] < [1-p_1(2)]/[1-p_2(2)]$ means that the probability of filing a claim is most similar between type 1 and 2 agents when s=1. Thus setting $c_2^2(2) < c_2^2(1)$ makes it least attractive to file a claim in the state (s=2) where type 1 agents are relatively more likely to do so. Thus setting $c_1^2(2) > c_1^2(1)$ and $c_2^2(2) < c_2^2(1)$ increases the perceived costs to a type 1 agent of buying an insurance contract from a mutual insurance firm, and hence such a contract structure maximizes incentives for self-selection to occur.

<u>Case 2</u>. $p_1(1)/p_2(1) < p_1(2)/p_2(2)$ and $[1-p_1(1)]/[1-p_2(1)] < [1-p_1(2)]/[1-p_2(2)]$. In this case $c_1^2(1) > c_1^2(2)$ and $c_2^2(1) > c_2^2(2)$. Intuitively, type 1 agents are relatively likely to file a claim when s=2, as in case 1. Thus optimal signalling dictates that $c_2^2(1) > c_2^2(2)$. Moreover, since $1 > p_1(2)/p_2(2) > p_1(1)/p_2(1)$, the probability of <u>not</u> filing a claim for type 1 agents is also high relative to type 2 agents when s=2. Therefore, incentives for self-selection are increased by setting $c_1^2(1) > c_1^2(2)$.

<u>Case 3</u>. $p_1(1)/p_2(1) < p_1(2)/p_2(2)$ and $[1-p_1(1)]/[1-p_2(1)] > [1-p_1(2)]/[1-p_2(2)]$. In this case $c_1^2(1) > c_1^2(2)$ and $c_2^2(2) > c_2^2(1)$. Thus, in this case, type 2 agents receive something closer to complete insurance in the "good" aggregate state (s=2) than in the "bad" aggregate state (s=1).

Again, the intuition revolves around setting $c_1^2(1) > c_1^2(2)$ because the probability of type 1 agents not filing claims in state 2 is relatively high. Similarly, the probability of type 1 agents filing claims is relatively high when s=1, so signalling considerations dictate that $c_2^2(2) > c_2^2(1)$.

C. Discussion

Perhaps the natural presumption is that agents purchasing insurance policies from mutual firms should receive more complete insurance when the aggregate experience of the firm is best (s=2). This does occur in case 3 above. However, it does not occur in case 1, and in case 2 total "rebates" from firms to policy holders are lowest in the "good" state (s=2). Should this be viewed as a troublesome aspect of the analysis? We think not. For instance, in agricultural credit markets the cooperatively organized farm credit system has increased rebates to borrowers recently, despite clearly having a poor aggregate experience.[9] Thus, in practice, behavior by cooperative organizations does sometimes mimic the outcome predicted in case 2, for instance.

V. Pareto Optimality

The introduction of aggregate uncertainty changes the predictions of a simple adverse selection model about the nature of insurance contracts that emerge when the Nash equilibrium concept of Rothschild and Stiglitz [1976] is imposed. In this section we briefly argue that the introduction of aggregate uncertainty has implications that are not dependent on the choice of an equilibrium concept. In particular, we show that the set of Pareto optimal allocations is altered by the introduction of aggregate uncertainty.

To do so, it is sufficient to argue as follows. Suppose that $p_i(1) = p_i(2)$; i=1,2 held, so that there was no genuine aggregate uncertainty here. Then, as shown by Prescott and Townsend [1984], any Pareto optimum would have $c^i_j(1) = c^i_j(2)\ \forall i,j$. Moreover, as Rothschild and Stiglitz and Prescott and Townsend show, in this case the equilibrium contracts derived in section III are Pareto optimal so long as

$$(20)\quad \left(\frac{\theta}{1-\theta}\right)\left[\frac{\bar{p}_2-\bar{p}_1}{\bar{p}_2(1-\bar{p}_2)}\right] \geq \frac{U'(c^*)[U'(\hat{c}^2_2) - U'(\hat{c}^2_1)]}{U'(\hat{c}^2_2)U'(\hat{c}^2_1)}.$$

When $p_i(1) < p_i(2)\ \forall i$, however, and when either (1) or (2) holds, the results of section IV imply that the allocation derived in section III can never be Pareto optimal. Thus the presence of aggregate uncertainty changes the set of Pareto optimal allocations for at least some parameters values (those satisfying (20)).

VI. Conclusion

Since our results depend on the occurrence of events that affect the probabilities of filing claims for all insured agents, and on either (1) or (2) holding, it seems appropriate to conclude by commenting on the plausibility of these assumptions. With respect to random aggregate events affecting the probability of filing claims for all agents, it would seem that this happens regularly in the auto insurance (weather) or life insurance (random developments in health care) industries. Mutual insurance firms are common in both industries. Moreover, it seems plausible that these random events affect the probabilities of claims being filed differently for different agents. For instance, bad weather may affect the relative occurrence of auto accidents across drivers who differ in terms of (unobservable) patience levels. Developments in health care will impact differently on different agents as well, in ways that might well depend on unobservable characteristics. Thus in those areas of insurance where mutual insurers are common, it seems quite reasonable to assume that aggregate uncertainty matters, and matters in ways that we require in order to explain the existence of mutual insurance firms.

University of Western Ontario
and Rochester Center for Economic Research

Federal Reserve Bank of Minneapolis
and University of Minnesota

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Notes

1. See Smith and Stutzer [1987b] for a discussion of cooperative lenders in agricultural credit markets.
2. See Smith and Stutzer [1987a] for such an interpretation.
3. We expect that some will question the appropriateness of assuming risk neutral insurance firms when there is aggregate ("undiversifiable") risk faced by these firms. However, if insurance firms are not risk neutral, or if they do not have resources permitting them to assume risk on behalf of those they insure, it is a foregone conclusion that insurance firms and insured agents must share aggregate risks. Thus we view our assumptions as being those that make the analysis interesting.
4. For justifications see Green [1984], Judd [1985] or Stutzer [1986].
5. (1) and (2) fail simultaneously iff $p_2(2) - p_2(1) = p_1(2) - p_1(1)$, or iff different realizations of s simply scale up accident probabilities in equal amounts for all agents.
6. This assumption is made to make the equilibrium that is derived here directly comparable to that of Rothschild and Stiglitz [1976].
7. The only one of these properties that may not be apparent in the presence of non-trivially state contingent contracts is (i). We therefore sketch a proof of property (i). Suppose, contrary to property (i), that a pooling contract can occur in equilibrium. Denote such a contract by values $c_j(s)$; $j,s=1,2$. We show that some firm has an incentive to offer a contract $c_j^2(s)$ that attracts type 2 agents only.

    In particular, construct the contract $c_j^2(s)$ as follows. Let $c_j^2(1) = c_j(1)$; $j=1,2$, and choose values $c_j^2(2)$ so that

$$p_1(2)U[c_1^2(2)] + [1-p_1(2)]U[c_2^2(2)] < p_1(2)U[c_1(2)] + [1-p_1(2)]U[c_2(2)]$$

$$p_2(2)U[c_1^2(2)] + [1-p_2(2)]U[c_2^2(2)] > p_2(2)\ U[c_1(2)] + [1 - p_2(2)]U[c_2(2)].$$

Such a choice is possible, since it simply reproduces such a construction in Rothschild-Stiglitz [1976] after s is realized. Then the contract $c_j^2(s)$ attracts all type 2 agents, and no type 1 agents. Moreover, if the contract $c_j(s)$ earns non-negative expected profits, the contract $c_j^2(s)$ earns positive expected profits if $c_j^2(2)$ is sufficiently close to $c_j(2)$; $j=1,2$. Thus the contract $c_j(s)$ cannot be offered in equilibrium, proving property (i).

8. See Smith and Stutzer [1987a].

9. For a discussion of this point, see Smith and Stutzer [1987b].

Rochester Center for Economic Research
University of Rochester
Department of Economics
Rochester, NY 14627

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