Competitive Insurance Markets under Adverse Selection and Capacity Constraints

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Abstract

Ever since the seminal work by Rothschild and Stiglitz (1976) on competitive insurance markets under adverse selection the equilibrium-non-existence problem has been one of the major puzzles in insurance economics.

We extend the original analysis by considering firms which face capacity constraints, which might be due to limited capital. We show that under mild assumptions a pure strategy equilibrium exists, where every consumer buys his appropriate Rothschild-Stiglitz contract.

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1 Introduction

Ever since the seminal work by Rothschild and Stiglitz (1976) on competitive insurance markets under adverse selection the equilibrium-non-existence problem has been one of the major puzzles in insurance economics and in information economics in general. The origin of this problem lies in the fact that only zero profit making separating contracts can constitute an equilibrium in the sense of Rothschild and Stiglitz, while in some cases a single pooling contract or a pair of cross-subsidizing contracts may be preferred by everyone and will therefore upset the Rothschild-Stiglitz equilibrium contracts.

There are many approaches to this problem in the literature. One way out of it is to allow firms to have mixed strategies (Dasgupta and Maskin, 1986), however the economic interpretation of this modification is not clear. Another possibility is to propose different equilibrium concepts (Wilson, 1977; Miyazaki, 1977; Spence, 1978; Riley, 1979), which however lack a game-theoretic foundation. There exist a few attempts of introducing some form of dynamics in a non-cooperative model (Jaynes, 1978; Hellwig, 1987, 1988; Asheim and Nilssen, 1997).[1]

In this paper we want to add one aspect to the discussion of the non-existence problem which so far has not received any attention in the insurance literature, and which lies at the heart of the non-existence problem: If a deviating firm offers a new set of contracts, who chooses these contracts? So far it was always assumed that any new contract offer can potentially serve the whole market. Here we assume instead that firms face capacity constraints. In that case it is no longer guaranteed that a new offer may attract a fair selection of the market. Indeed, the distribution of risk types applying for a (deviating) contract at a given firm is now determined endogenously.

One reason for capacity constraints can be solvency regulation: For a given size of capital, only a finite number of risks can be added to the portfolio of the insurer, as otherwise, depending on how the solvency requirement is specified, the ratio of premium income to capital or the ratio of risk exposure to capital exceeds a given size.[2][3]

[1] Recently, an evolutionary model of the insurance market has been proposed (Ania et al., 1998). If firms copy profit making contracts and experiment with their own contracts locally, the unique long run outcome is that all firms offer the Rothschild-Stiglitz contracts.

[2] In a recent article, the ECONOMIST (16th January 1999, 'The Insurance Bust') argues that there is too much capacity, i.e., capital, in the insurance market which lead to falling premiums. The author recommends insurers to pay back capital to the shareholders.

[3] Buying reinsurance is a means to increase capacity, however at a cost. If these costs are not

Another argument why a firm might not serve the whole market could be the mere size of the firm, the number of employees, the size of the computer system, etc., which makes it difficult to process more than a given number of policies.

Under capacity constraints, our main result is that the Rothschild-Stiglitz (RS) contracts are stable, even if they are not equilibrium contracts of the original game. For an illustration, consider pooling contracts which were used to destabilize the RS contracts in the original paper. If the new contract is supposed to also attract low-risk types and if the proposer intends to realize a strictly positive profit, the coverage of the low-risk type must increase compared to the RS contract. Observe now that the high-risk type's incentive compatibility constraint is binding under the RS allocation and that he benefits strictly more from an increase in the coverage (due to the single-crossing property). Hence, the high-risk type's utility will increase strictly more under the deviating contract. As a consequence, high risks are prepared to endure a more severe rationing in case a firm's capacity constraint becomes binding. This intuitive property can now be applied to make any deviating offer, even with a pair of contracts, unprofitable as it simply will not assure the firm the desired mix of types.[4]

The insurance sector is only one example of a market with adverse selection, where capacity constraints might be useful to guarantee existence of an equilibrium in pure strategies. Similar reasoning would apply to the banking market, where customers with good and bad projects demand loans (Stiglitz and Weiss, 1981; Bester, 1985). Also venture capitalists suffer from adverse selection, if entrepreneurs are of different quality. In both these markets, capacity constraints arise in the form of limited capital, which prevents a single bank/venture capitalist to serve the whole market. Also in the labor market, where workers are of either high or low productivity, adverse selection can become relevant (see e.g. Mas-Colell et al., 1995, Chapter 13; Landers, Rebitzer, and Taylor, 1996). Here limited capacity would be the finite number of slots each individual

negligible, our result remains to hold. See Berger et al. (1992) for an account of the spillover effects from the reinsurance market to the primary insurance market in the liability insurance crisis in the mid-1980s.

[4] This paper is not the first to use rationing and congestion in markets with adverse selection. Congestion has also been applied as an equilibrating device by Inderst (1998) and Inderst and Müller (1999) in markets for lemons where there is no contractual sorting variable. Gale (1992, 1996) considers a Walrasian approach where each contract represents a separate trading environment. In contrast to us he takes a one-shot perspective where rationed individuals cannot trade subsequently. Moreover, instead of solving a fully defined game, he imposes market clearing conditions and uses refinements to reduce the multiplicity of equilibria.

firm has to fill.

The rest of this paper is organized as follows. Section 2 introduces the model, which is solved in Section 3. We conclude in Section 4.

2 The Model

The insurance market is populated by $F = \{1, ..., F\}$ risk-neutral firms, each with a fixed capacity of $k_f > 0$. On the demand side there are $N = \{1, ..., N\}$ customers. We assume that $k_f < N$ holds for all $f \in F$ and that $\sum_{f \in F'} k_f \geq N$ holds for all sets $F' = F / \{f\}$ with $f \in F$. Hence, no single firm can serve the whole market, while all but one firm together are sufficient to serve all customers.[5] The customers face a risk of loosing a sum S. An individual may have either a high risk probability of π_H or a low risk probability $\pi_L < \pi_H$. The respective risk type of customer n is denoted by $t_n \in T = \{L, H\}$. All individuals have the same von Neuman-Morgenstern utility function $U(w)$. Below we will invoke a further assumption on the severeness of the capacity constraint to support an equilibrium.

The game is modelled as follows:

Stage 0: The risk type of each individual is chosen by nature. Each person has the chance of γ_H $(1 - \gamma_H)$ to be a high (low) risk type. This draw is taken independent across individuals, so that overall the expected number of high risks is $\gamma_H N$.

Stage 1: Firm f, $f = 1, ..., F$, sets a menu of contracts $\{\omega_1^f, \omega_2^f, ..., \omega_k^f\}$ where each ω_l^f specifies a premium P_l^f and a net indemnity payment I_l^f.

Stage 2: Each customer either chooses a firm f and a contract ω_l^f or decides not to visit any firm.

If the number of customers choosing firm f, which we denote by n_f, does not exceed k_f, then each customer obtains his desired contract. The expected utility if the chosen contract ω specifies the premium P and the net indemnity I is abbreviated by

$$U_t^E(\omega) = (1 - \pi_t)U(w - P) + \pi_t U(w - S + I),$$

[5] This assumption is a simplification of the capacity problem due to limited capital. Given any amount of capital, k_f will in general depend on the form of the contracts offered and the types of the insured buying these contracts. However, we conjecture that making k_f an endogenous variable will not change the result. The important assumption we require is that there are enough firms to serve the least-cost separating contracts without incurring capacity constraints, while any single firm will run into severe capacity problems if it tries to serve a significant fraction of the market.

where the risk type t is either H or L. If n_f is larger than k_f, the firm runs into capacity constraints and has to apply a rationing scheme. We assume that rationing occurs randomly over all applicants.[6] Hence, each individual is rationed with probability $\rho_f = 1 - \min\{1, k_f/n_f\}$. If some customers do not obtain a contract, Stage 3 follows.

Stage 3: The customer can either choose to remain uninsured or he can visit another firm f' which still has free capacity available and pick a contract $\omega_l^{f'}$ from the menu of contracts of firm f'. The search for a new firm is costly. We measure these costs in utility units and assume that approaching another firm results in costs $u > 0$, which are independent of the risk type.[7] If the customer has chosen a firm f' where again demand exceeds supply, and he did not obtain a contract, Stage 3 is repeated.

3 Rothschild-Stiglitz Contracts as Equilibrium Contracts

Let us first recall the pair of RS contracts, which are the least-cost separating contracts. They are uniquely derived by the following conditions.

The RS contract ω_H^{RS} for the high-risk type specifies full coverage with $I_H^{RS} = S - P_H^{RS}$, while the premium is determined by the zero-profit condition for the risk-neutral insurer as $P_H^{RS} = \pi_H S$. We denote the realized (expected) utility by $U_H^{RS} = U_H^E(\omega_H^{RS})$.

The RS contract ω_L^{RS} for the low-risk type is chosen to maximize $U_L^E(\omega)$ subject to the firms' participation constraint $P \geq I\pi_L/(1-\pi_L)$ and the high-risk type's incentive compatibility constraint $U_H^{RS} \geq U_H^E(\omega)$. It can be shown that both constraints become binding, while the contract provides less than full coverage with $I_L^{RS} < S - P_L^{RS}$. We denote the utility by $U_L^{RS} = U_L^E(\omega_L^{RS})$. Denote $U_t^0 = U_t^E(0,0)$ for the expected utility without insurance coverage. It is clear that U_L^{RS} exceeds the expected utility from staying uninsured U_L^0.

[6] This rationing scheme can be motivated by assuming that customers visit the insurer one after the other in a random order. Additionally, it can be shown that our results still apply if we allow firms to offer more complicated mechanisms, which e.g., give different contracts a different priority when the firm must ration. Indeed, this follows immediately from incentive compatibility. Allowing for such mechanisms on a general level would, however, severely complicate the notation without adding insights.

[7] Note that we assume that the first visit is free. Our results continue to hold if the costs of a first visit do not exceed the difference between the utility derived by the low-risk type under his Rothschild-Stiglitz contract and his utility without insurance.

The contracts are shown in Figure 1.

Figure 1 here.

On the two axes are the premium and the gross indemnity $G = I + P$. Full insurance is obtained at the vertical line which is given by $G = S$. The three straight lines denote the zero-profit lines, if only high risks (the top line), only low risks (the bottom line), or a mixture of the two risks buy such a contract. Note that with the pooling line as drawn, a contract like ω would be preferred by everyone and would be strictly profitable if it can assure a fair selection.

Throughout this paper we focus on (subgame-perfect) equilibria where firms play pure strategies in Stage 1. As the number of firms is finite, the market will always clear after a finite number of repetitions of Stage 3. Hence, once contracts are in place, we face a finite (continuation) game, which therefore has always an equilibrium in (possibly mixed) strategies.

As indicated in the introduction, the novel feature of our approach to markets with adverse selection is that we abandon the particular specification in the Rothschild-Stiglitz environment that a deviator can either serve the whole market or can always assure himself a fair selection of risks. For our result to hold we require that the capacity problem is sufficiently severe. This contains three elements:

First, the search costs u should not be negligible. Suppose otherwise: For search costs of zero there are no direct costs of being rationed by a firm which makes a deviating offer. Thus again, everyone might try to obtain such a contract which in turn makes the distribution of risks equal to the distribution in society.

Second, search costs u should not be too high. Otherwise, consumers only have one possibility to search around. If they do not receive a contract at their first firm, they prefer to stay uninsured. As high risks suffer more from being uninsured, by offering a contract which is going to be rationed firms might deter high risks from choosing this contract.

Third, the capacity of a single firm must be sufficiently low compared to the economy. If not, any firm would by offering a deviating contract attract maybe not all of the population, but nearly all. This would make the risk distribution more and more favorable.

We next provide a formalization of these assumptions. (A.1) assures that rationed players prefer to newly approach an insurer to sign their respective RS contract instead of staying uninsured.

Assumption (A.1)

$$U_t^{RS} - u > U_t^0 \quad \text{for} \quad t \in \{L, H\} \tag{1}$$

We next derive a combined requirement which puts a lower bound on the search costs u, while assuring that capacity is sufficiently dispersed. Let $k^M = \max_{f \in F} k_f$ be the maximum capacity of a single firm. Recall next that at Stage 0 the type of an individual is determined randomly. Therefore, the true distribution of types in the population is unknown to all market participants.[8] Suppose that individual n expects that all high-risk individuals choose to visit a particular firm f with the maximum capacity k^M, while all low-risk individuals pick different firms. This allows us to calculate an expected rationing probability for individual n if he chooses firm f as well. We denote this probability by ρ^M.[9] Let U_H^P be the expected utility of a high risk under his preferred contract with a fair pooling premium, i.e. the utility from a contract ω satisfying $P\left[\gamma_H(1-\pi_H)+(1-\gamma_H)(1-\pi_L)\right] = I\left[\gamma_H\pi_H+(1-\gamma_H)\pi_L\right]$, where I is chosen optimally.

Assumption (A.2).

$$(1-\rho^M)U_H^P + \rho^M\left(U_H^{RS} - u\right) < U_H^{RS}. \tag{2}$$

Assumption (A.2) implies that if individuum n is a high risk, he is better off buying his RS contract than queueing at a firm together with all other high risks for the insurance contract at the pooling premium, and in case he is unlucky in the draw, buying the RS contract in the next round. That is the expected rationing at one single firm is sufficiently severe if all high risks are expected to turn up.

Note that (A.2) holds for a given level of u if the number of customers N is sufficiently large and if the capacity is sufficiently dispersed among firms. To see this, consider a sequence of economies where the expected fraction of high-risk types $0 < \gamma_H < 1$ is

[8] By the law of large numbers this uncertainty vanishes as the number of individuals increases.

[9] Formally, suppose that there are N_H high risks visiting firm f in addition to individual i. This gives rise to the rationing probability $\rho^M(N_H) = 1 - min\left\{1, k^M/(N_H+1)\right\}$. The probability that there are exactly m high risks in the population is equal to $Pr(N_H = m) = \binom{N-1}{m}\gamma_H^m(1-\gamma_H)^{N-1-m}$, such that $\rho^M = \sum_{m=0}^{N-1} Pr(N_H = m)\rho^M(N_H)$.

kept fixed together with the maximum capacity k^M of a single insurer. If the size of the economy N increases, ρ^M will converge to 1, so that (2) is satisfied for any positive costs $u > 0$. Thus a limit result holds: For any type distribution and capacity per firm, if the economy is replicated often enough, (A.2) will hold.

We can now prove our main result.

Proposition *If Assumptions (A.1)-(A.2) hold, there exists an equilibrium where any customer $n \in N$ realizes his respective RS contract at stage 2.*

Proof: We claim that one possible equilibrium strategy of firms is to offer the two RS contracts each. Given that these contracts are offered, the customers face a coordination problem. We solve the problem by ordering individuals as follows. Customer n turns to firm f where the index f satisfies $\sum_{f'=1}^{f} k_{f'} \geq n$ and $\sum_{f'=1}^{f-1} k_{f'} < n$. He demands the high- or low-risk contract, depending on his type t_n. Given the contract offers, no customer has an incentive to deviate, as all are served with the best possible contract on offer and no rationing occurs. Moreover, all firms make zero profit with these contracts. To support the resulting allocation as an equilibrium, it thus remains to specify strategies if a single firm deviates to a different menu of contracts in order to show that there are no profitable deviations.[10]

Recall that in the standard discussion by Rothschild and Stiglitz, a pooling profit-making contract as shown in Figure 1 might be just such a profitable deviation. However, in our model, we must consider any possible deviation by some firm $\bar{f}$ consisting of a menu $\{\bar{\omega}_1^{\bar{f}}, \bar{\omega}_2^{\bar{f}}, ..., \bar{\omega}_k^{\bar{f}}\}$ of contracts. Rationing, if it occurs, is the same for all customers of a single firm. Therefore we can, without loss of generality, reduce the menu to two contracts, one for each type, which are denoted by $\bar{\omega}_H$ and $\bar{\omega}_L$.[11] Moreover, these contracts must be incentive compatible.

If there is rationing at $\bar{f}$ in Stage 2, we specify that individuals who are not allocated a contract and who choose to visit another firm in Stage 3 will again perfectly resolve the coordination problem in Stage 3 and will thus realize their respective utilities $U_t^{RS} - u$ with one period delay. (Note that there is enough capacity as the remaining $F-1$ firms

[10] We do not specify the whole equilibrium strategy of the customers, which depends on his type realization at Stage 0 and on all possible contract offers by the firms. Instead, we only discuss that part of the strategies which conditions on the relevant contract offers.

[11] With a slight abuse of notation this also covers the case where only a single contract is offered. In this case set $\bar{\omega}_L = \bar{\omega}_H$.

offer the RS menu and as $\sum_{f\in F/\{\bar{f}\}} k_f \geq N$.) The expected utility of a type t who visits the deviating firm is therefore equal to

$$U_t^D(\bar{\omega}_t, \rho) = (1-\rho)U_t^E(\bar{\omega}_t) + \rho(U_t^{RS} - u). \tag{3}$$

where ρ is the expected rationing probability at firm $\bar{f}$.

As the high risks obtain full insurance at their fair premium, a deviating offer must be supposed to attract (some) low-risk types, because otherwise there would be no scope to increase profits above zero. This already implies $U_L^E(\bar{\omega}_L) \geq U_L^{RS}$. As can be seen in Figure 1, if expected profits are positive, this can only hold if this offer involves more coverage $\bar{I}_L > I_L^{RS}$ and also a higher premium $\bar{P}_L > P_L^{RS}$ than the RS contract for the low-risk type. We claim that for any menu satisfying these conditions for the low-risk contract there exists a (continuation) equilibrium where only high-risk types turn up at the deviator.

First, note that the high risks strictly prefer the contract designed for the low risks to their RS contract, i.e. $U_H^E(\bar{\omega}_L) > U_H^{RS}$. To see this, recall that the RS contracts were chosen such that $U_H^E(\omega_L^{RS}) = U_H^{RS}$. As the deviating menu satisfies $U_L^E(\bar{\omega}_L) \geq U_L^{RS}$ and $\bar{I}_L > I_L^{RS}$, the asserted strict inequality is immediate from the single-crossing property, which is illustrated in Figure 1. As a consequence, it holds that $U_H^E(\bar{\omega}_H) > U_H^{RS}$, while $U_H^D(\bar{\omega}_H, \rho)$ is strictly decreasing in the expected rationing probability ρ.

We show now that we can specify a continuation equilibrium where for a value $0 < \phi < 1$ all individuals $n \in \{1, .., N\}$ visit $\bar{f}$ in Stage 2 with probability ϕ if and only if they are of the high-risk type. With probability $1-\phi$ a high-risk type turns to a firm where he obtains his RS contract with probability one. Low-risk types choose a firm other than $\bar{f}$ with probability one in order to buy their RS contract. (As any firm, including $\bar{f}$, is dispensable to serve the whole market, customers can indeed perfectly resolve their coordination problem when choosing a firm other than $\bar{f}$.) For a given ϕ we can calculate the expected rationing probability $\rho(\phi)$ for an individual who contemplates choosing firm $\bar{f}$.[12] Note that $\rho(\phi)$ is strictly increasing in ϕ.

We show first that there exists a unique $0 < \phi < 1$ satisfying

$$U_H^D(\bar{\omega}_H, \rho(\phi)) = U_H^{RS}. \tag{4}$$

[12] Formally, $\rho(\phi) = 1 - \sum_{m=0}^{N-1} \binom{N-1}{m} (\phi\gamma_H)^m (1-\phi\gamma_H)^{N-1-m} min\left\{1, k_{\bar{f}}/(m+1)\right\}$.

That is, there exists a probability ϕ smaller than one at which high risks are indeed indifferent between joining the queue and choosing the RS contract. Recall that $U_H^D(\bar{\omega}_H, \rho)$ is strictly decreasing and continuous in ρ, while $\rho(\phi)$ is strictly increasing and continuous in ϕ. Moreover, it holds that $U_H^D(\bar{\omega}_H, \rho(0)) > U_H^{RS}$. It remains to prove that $U_H^D(\bar{\omega}_H, \rho(1)) \leq U_H^{RS}$. The argument is by contradiction. Suppose there exists a profitable deviation such that $U_H^D(\bar{\omega}_H, \rho(1)) \geq U_H^{RS}$, i.e., where every high-risk individual could turn up and (in expectancy) realize not less than by buying instead the RS contract. Note next that $\rho(1) = \rho^M$, which was defined before invoking (A.2). To ensure that the deviating firm $\bar{f}$ still realizes nonnegative payoffs if it is visited by all available high-risk types, $U_H^E(\bar{\omega}_H)$ must be bounded from above by U_H^P, as defined before (A.2). With these preliminary remarks, it follows immediately that the claim $U_H^D(\bar{\omega}_H, \rho(1)) \geq U_H^{RS}$ contradicts (A.2).

It now remains to show that, given the uniquely chosen $0 < \phi < 1$ satisfying (4), it does not pay any low-risk type to visit $\bar{f}$. Recall first that by (A.1) and our specification of continuation strategies at Stage 3, an individual implements his RS contract at Stage 3 if he was rationed when visiting $\bar{f}$ at Stage 2. It therefore remains to show that $U_L^D(\bar{\omega}_L, \rho(\phi)) \leq U_L^{RS}$. This again holds if $U_H^E(\bar{\omega}_H) - U_H^{RS}$ is not smaller than $U_L^E(\bar{\omega}_L) - U_L^{RS}$, which after substitution of $U_H^E(\omega_L^{RS}) = U_H^{RS}$ and $U_H^E(\bar{\omega}_H) \geq U_H^E(\bar{\omega}_L)$ holds if

$$U_L^E(\bar{\omega}_L) - U_L^E(\omega_L^{RS}) \leq U_H^E(\bar{\omega}_L) - U_H^E(\omega_L^{RS}). \tag{5}$$

But this must be satisfied even strictly due to the single-crossing property, $\bar{I}_L > I_L^{RS}$, and $\bar{P}_L > P_L^{RS}$.[13] **Q.E.D.**

The proposition has a simple intuition which comes out most clearly if we suppose that a deviating offer intends to attract a mixed set of types. To realize a profit with low-risk types, the offer must specify a higher coverage than the RS contract designated for these types. By the single-crossing property, high-risk types gain more under the new offer than low-risk types. They are thus prepared to accept a higher (expected) rationing probability than low-risk types who would not apply for the deviating offer at this level of congestion.

Standard analysis of competitive insurance markets under adverse selection has shown that if the ratio of high risk to low risk types is small no equilibrium in pure strategies

[13] Note that inequality (5) is equivalent to $(\pi_H - \pi_L)[U(w - \bar{P}_L) - U(w - P_L^{RS})] + (\pi_L - \pi_H)[U(w - S + \bar{I}_L) - U(w - S + I_L^{RS})] \leq 0$.

exists. Contrary to this result, the proposition and the remarks we made before on Assumption (A.2) imply that for *any* distribution of risk types we can find an economy in which capacity is sufficiently dispersed among firms such that an equilibrium where insurer all offer the same contracts exists.

In a previous version of this paper we have shown that the analogue of the proposition holds if firms can potentially serve all customers, but face the risk of bankruptcy. If acquisition of further contracts increases the bankruptcy risk, then more customers will make each policy less attractive to a potential insured.[14] This in effect restricts the number of applicants for any contract offer. Therefore also in this setup one can devise equilibrium strategies such that only high risks turn up at a deviating firm.

4 Conclusion

We showed how an existence result in pure strategies can be obtained for an insurance market if there is limited capacity to write contracts, which moreover is sufficiently dispersed among the competing firms. A family of (least-cost separating) Rothschild-Stiglitz contracts cannot be destabilized by a supposedly pooling deviation as the congestion resulting from applying high-risk types, who have more to gain, will make low-risk types strictly prefer to take up their prescribed equilibrium contract at another firm.

The derived equilibrium is not unique under capacity constraints. In particular, the possibility of coordination failure among customers allows to support equilibria where firms make positive profit even though each individual firm is dispensable. Under complete information this has been shown by Peters (1984). In Inderst (1999) we discuss (under complete information) two ways to make prices converge to the unique "competitive" outcome. First, if the number of buyers increases while the ratio of capacity to buyers and the number of firms stay constant, coordination is facilitated as buyers predict more accurately the congestion prevailing at an individual seller. Secondly, coordination failure becomes less serious if the costs of visiting another seller decrease. It remains to see how these arguments can be exploited to restrict the set of equilibria for the insurance model analyzed in this paper.[15]

[14] A more detailed model of insurers facing bankruptcy is given in Rees et al. (1999).

[15] In Inderst and Wambach (1999) we study a labor market with a continuum of workers where

5 References

Ania, A., T. Tröger, and A. Wambach (1998): An evolutionary analysis of an insurance market under adverse selection, *University of Vienna working paper 9808*

Asheim, G.B. and T. Nilssen (1996): Non-discriminating renegotiation in a competitive insurance market, *European Economic Review* 10, 1717-1736

Berger, L.A., J.D. Cummins and S. Tennyson (1992): Reinsurance and the liability insurance crisis, *Journal of Risk and Uncertainty* 5, 253-272

Bester, H. (1985): Screening vs. rationing in credit markets with imperfect information, *American Economic Review*, 850-855

Dasgupta, P. and E. Maskin (1986): The existence of equilibrium in discontinuous economic games, II: Applications, *Review of Economic Studies* 53, 27-41

Gale, D. (1992): A Walrasian theory of markets with adverse selection, *Review of Economic Studies* 59, 229-55

Gale, D. (1996): Equilibria and Pareto optima in markets with adverse selection, *Economic Theory* 7, 207-35

Hellwig, M.F. (1987): Some recent developments in the theory of competition in markets with adverse selection, *European Economic Review* 31, 319-325

Hellwig, M.F. (1988): A note on the specification of interfirm communication in insurance markets with adverse selection, *Journal of Economic Theory* 46, 154-163

Inderst, R. (1998): Efficiency wages under adverse selection and the role of rigid wages, mimeo

Inderst, R. (1999): A note on the strategic foundation of competitive equilibrium in buyer markets, mimeo

Inderst, R. and H.M. Müller (1999): Why lemons trade at different prices than plums, mimeo

rationed workers stay unemployed. We show that only the RS allocation arises in equilibrium.

Inderst, R. and A. Wambach (1999): Capacity constrained firms in (labor) markets with adverse selection, mimeo

Jaynes, G.D. (1978): Equilibria in monopolistically competitive insurance markets, *Journal of Economic Theory* 19, 394-422

Landers, R., Rebitzer, J., and L. Taylor (1996): Rat Race Redux: Adverse selection in the determination of work hours in law firms, *American Economic Review* 86, 329-348

Mas-Colell, A., Whinston, M. D., Green, J.R. (1995): *Microeconomic Theory,* Oxford University Press.

Miyazaki, H. (1977): The rat race and internal labor markets, *Bell Journal of Economics* 8, 394-418

Peters, M. (1984): Bertrand equilibrium with capacity constraints and restricted mobility, *Econometrica* 52, 1117-27

Rees, R., H. Gravelle, and A. Wambach (1999): Regulation of insurance markets, *Geneva Papers on Risk and Insurance Theory* 24, 55-68

Riley, J.G. (1979): Informational equilibrium, *Econometrica* 47, 331-359

Rothschild, M. and J. Stiglitz (1976): Equilibrium in competitive insurance markets: An essay on the economics of imperfect information, *Quarterly Journal of Economics* 90, 629-649

Stiglitz, J. and A. Weiss (1981): Credit rationing with imperfect information, *American Economic Review* 71, 393-410

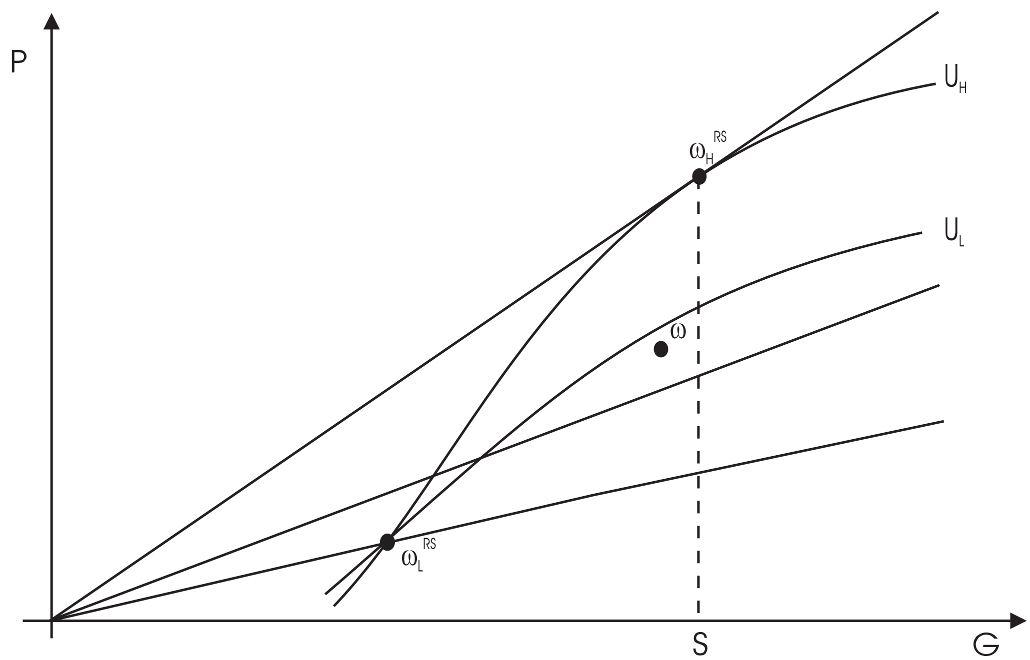

Figure 1: Rothschild-Stiglitz contracts.