Renegotiation before Contract Execution

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Abstract

By offering or choosing a contract the informed agent might reveal information to the principal which could be used for immediate renegotiation. This is discussed in an axiomatic approach.

We show that if, given the revealed information, there exists a contract which is preferred by everyone, the former contract could not have been renegotiation proof. For private values and common values of the 'Spence' type, a generalised Coase Conjecture holds: The principal cannot raise her profit by offering inefficient contracts to the agent. Only for common values of the 'Rothschild-Stiglitz' type, inefficient, but pooling, contracts are possible.

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1 Introduction

Over the last 30 years, the concept of asymmetric information has entered nearly every area in economics. In all cases where two or more parties are to agree about something, asymmetric information can be an issue. This holds in financial markets as well as in products markets, whether two parties are bargaining or two countries are negotiating.

Usually it is assumed that there are two parties out of which one has private information, i.e. there is one (discrete or continuous) parameter which is unobservable for the other party. In standard models in the literature one of the two parties proposes a contract or a menu of contracts, which is designed such that the other party accepts it. Depending on who makes this offer we talk about screening or signalling models.

The formalism of these models is well developed: in essence, these models lead to the introduction of a new constraint, the so called incentive compatibility constraint. In equilibrium the contract which is chosen or offered by any type must be that contract from the equilibrium menu of contracts which gives him the highest utility. In screening models for example, the uninformed party proposes a menu of contracts, out of which the informed party choses the one which is optimal for him. Then the contract is exercised.

There is however one critical assumption in this approach - the parties will not change the contract after the informed party has made its choice. In general, however, by offering or choosing a contract the informed party reveals information to the uninformed person. As typically the contracts are inefficient, on the basis of this new information there might exist another contract which is preferred by both parties.

In the literature this effect is known as the renegotiation problem. Both parties cannot commit themselves not to change the contract after some information is revealed. However, the literature so far has mainly concentrated on dynamic principal agent problems where the renegotiation problem occurs in the second and later periods, i.e. after the first period contract has already been exercised.

In this paper we want to take the discussion one step back, and consider the possibility of renegotiation at the first period, *before* the contract is executed.

Why should this be relevant? Consider a standard principal agent problem where a monopolist sells a divisible good to customers who have different valuations for this good. As is well known, the second best contract menu for the monopolist is a series of distorting contracts, with all but the person with the highest valuation receiving a quantity less than the optimal one. Under some minor assumptions, in equilibrium all types separate. But now consider the renegotiation problem - assume that all types separate, but most of them are treated inefficiently. In that case both the monopolist as well as the customer have an incentive to change the conditions of their individual contract already before execution of the contract. Thus the contract could not have been an equilibrium contract in the first place.[1]

For many models in the literature allowing the two parties to renegotiate immediately seems to be a sensible assumption. Apart from the monopolist it might be relevant for an insurer, who faces different unobservable risk types. For other models renegotiation before contract execution will not be an issue. Consider e.g. the regulation model by Laffont and Tirole (1986). Here the regulator offers a contract menu specifying cost levels and transfers. The individual firm does not have to specify ex-ante which contract it prefers, the information is only revealed in the next period when the firm delivers the size of the costs and receives the appropriate transfer. By accepting the contract menu no change in the information structure on the side of the regulator takes place, so there is no reason to modify or renegotiate the contract. A similar argument holds in the case of signalling models where the signalling costs are incurred before the contract is offered, as it is the case in Spence's (1973) 'education as a signal' model. There is no need to renegotiate the contract as the signal is fully revealing and the inefficiencies have occured already. However, for other signalling models, where the signal is part of the contract, renegotiation becomes an issue.[2]

The literature on renegotiation is large and growing (see Dewatripont and Maskin, 1990, for an overview). Most papers take a non-cooperative approach to model the effects of renegotiation, but, as mentioned above, only allow for renegotiation after the first contract has been executed. One exception is the work by Beaudry and Poitevin (1993, 1995). These authors discuss the effects of immediate renegotiation in a general signalling model, and for a competitive financial market. The problem the non-cooperative approach faces, however, is that the results depend very delicately on the assumptions on the setup of the game. In Beaudry and Poitevin, for example, the equilibrium separating contract is sustained by the threat that if someone who signs an inefficient contract tries to offer a new contract, the uninformed party will assume that this person is of the

[1] A similar motivation for this work in the case of an insurance contract can be found in Kreps (1990, pp.677-679).

[2] Another reason why the initially offered contracts will not be changed may be that the proposing party can credibly commit herself not to renegotiate because of reputational concerns. However, this will only hold in a repeated game situation, which should then be explicitely modelled. In insurance markets, for example, by the use of 'experience rating' the first best can be achieved, if the contract is of sufficiently long duration.

undesired type - a switch of belief takes place. This can only stabilize the situation if it is always the informed party who makes the contract offer, which in turn is specified in the setup of the game. In reality, however, one should expect that both parties have the ability to propose modifications to an existing contract.[3]

In the present paper we discuss the renegotiation problem within an axiomatic approach, which is independent of who makes which offer when. The approach is based on the work by Greenberg (1990) and Asheim and Nilssen (1997), and is close to the core concept in economies with asymmetric information.[4] It specifies consistency requirements for a contract and a corrsponding type profile to be a possible final outcome. In essence these are:

1) For every possible situation there must exist a renegotiation proof outcome which does not make anyone worse off ('external stability') and

2) for any renegotiation proof outcome, any other renegotiation proof outcome must make the principal not better off ('internal stability').

These consistency requirements are very similar to the coalition proof equilibrium concept used by Kahn and Mookherjee (1995) and Lacker and Weinberg (1993). Apart from the fact that they discuss large populations with different types while we consider a principal agent setup, the main difference in focus is that they explicitly consider the incentives types in the non-deviating coalition have in joining a deviating coalition. This is explicitely ruled out in our renegotiation model: It is conceivable to renegotiate only with those types who have revealed themselves by choosing a particular contract.

In our paper we obtain the following results:

First, a necessary condition for a contract to be renegotiation proof is that, based on the information revealed by choosing this contract, there does not exist a *single* contract

[3]Another example which makes this point is given by the papers by Fudenberg and Tirole (1990) and Ma (1994), where a minor change in the setup of the renegotiation procedure leads to substantially different results. Both papers discuss a moral hazard problem, where after the agent has choosen his effort level, a new contract can be proposed. In Fudenberg and Tirole it is the uninformed principal who offers the new contract. As a result no single effort level (apart from the minimum effort level) can be implemented. In equilibrium the agent chooses a distribution over effort. On the other hand, in Ma's paper it is the agent who offers the new contract. Ma shows that under appropriate belief refinements the standard second best contract can be sustained. The reason is that by offering a contract the agent reveals information about the effort he has chosen.

[4]Greenberg does not discuss asymmetric information, and Asheim and Nilssen are concerned with a two type insurance market where both types have constant relative risk aversion. Here we modify and generalize the approach to principal agent problems.

which is preferred by every type who has chosen this contract and by the uninformed party. An immediate consequence is that inefficient separating contracts cannot be final outcomes. This result stands in contrast to Beaudry and Poitevin (1993, 1995), who show that full separation with inefficient contracts is possible. As we have mentioned above, this result may be a consequence of the specific setup of the game. Furthermore, a 'switch of belief', which the authors use along the out of equilibrium path, will not occur in our axiomatic setup.

Second, any efficient contract and corresponding type profile, which has the property that even under perfect information no better outcome can be reached, has to be renegotiation proof. This seems to be obvious, but it turns out to be a very powerful tool to prove the following results.

Third, in the private value case, only efficient and fully separating outcomes can be renegotiation proof. In the case where the principal has all the bargaining power, i.e. a screening model, this result is a generalized Coase conjecture. Coase considers a monopolist who sells an indivisible good to customers with different valuations. He argues that if the monopolist competes with herself over time, prices will be driven down to marginal costs. The reason is that for a given price above marginal costs, there are always potential buyers who have not bought the good so far, and which the monopolist will reach by lowering the price. But not selling to customers with low valuation is the same as offering distorted contracts to them, which explains the analogy. As Coase has argued that the monopoly problem will cease to exist, this result shows that the intuition gained by the principal agent literature, namely that the principal distorts types to gain larger profits, will not hold in the private value case once renegotiation is allowed.

In the common value case we have to distinguish between two forms of common values. In the 'Spence' case (S), both the principal and the agent have the same ranking over marginal trade offs, e.g. education is marginally more productive and less costly for the high type (Spence, 1973). In the 'Rothschild Stiglitz' case (RS), the reverse holds. Marginal insurance is more valuable but more costly for the high risk type (Rothschild and Stiglitz, 1976).[5] Our fourth result is that in 'Spence' case of common values, again only non-distorting contracts can be equilibrium outcomes. Neither the principal in a screening nor the agent in a signalling model can increase their utility by using distorting contracts. In the Spence education model where education has no productive value, this implies that if wages and education are bargained over, only contracts with zero education

[5]This distinction follows the line of Beaudry and Poitevin (1993).

can be sustained. Education looses its signalling value.

Fifth, only in the common value case of the RS type are distorting contracts possible (and sometimes necessary). In the insurance context this implies that partial insurance contracts are feasible. However, following result one above, these contracts have to be (partial) pooling contracts, i.e. more than one risk type has to choose this contract.

It seems to be a preconception in the literature that "the possibility of future renegotiation can only hurt parties" (Dewatripont and Maskin, 1990). In screening models, for example, it is obvious that if such a renegotiation proof contract exists it will do worse for the principal than the standard second best separating contract. This just follows by noting that the principal still solves the same problem, but now under some additional constraints. Similarly, in a signalling model the agents are in general not better off if renegotiation is introduced. However, because the possibility to renegotiate weakens the bargaining power of the offering party, this may well lead to an improvement for the accepting party. In the private value and the 'Spence' common value case mentioned above, for example, if the principal has the bargaining power, the agent gains from renegotiation. Thus the net result of the possibility to renegotiate is not clear.

In a companion paper (Wambach, 1999) we show that for a monopolist selling an indivisible good to customers with different valuations, distorting contracts can actually be obtained if costs lie in between the range of valuations.[6] The difference to the present model is that screening along a further variable is not possible, as consumers can only buy one unit or no units of the good. Furthermore, one type of buyer has to have valuation equal to the cost of the seller, so that both trade and no trade are efficient outcomes for this type.

The paper is organized as follows: In section 2 we introduce the axiomatic approach and derive the general results. In section 3 the case of private values is considered, while in section 4 common values are discussed. Section 5 summarizes the results and concludes.

[6] This rediscovers the famous 'gap-no gap' result known from the non-cooperative literature (Fudenberg, Levine and Tirole, 1985; Ausubel and Deneckere, 1989).

2 Renegotiation Proof Contracts

Consider the bargaining process between an uninformed individual (call her the principal) and an informed individual (the agent).[7]

Either the principal offers a menu of contracts to the agent out of which the agent chooses one, or the agent offers a contract to the principal which she may accept or not. This in turn reveals information about the type of the agent. We are interested in the properties of the contract or the contract menu which will ensure that these are indeed final contracts, i.e. even after revealing the information both parties will refrain from negotiating again.[8] Note that all the arguments we give in the following hold for the screening situation, where the principal makes the offer, as well as the signalling case, where the agent offers the contract. What is of interest for us is which contract will be signed at the end of the day and from which no further negotiation will take place. Whether this contract was proposed by the agent or by the principal, or who of the two accepted this contract, will not play a role. Only for the question of who will appropriate the gains from trade does the difference between signalling and screening matter. In the 'screening' case, the principal would like to push the agents on their zero utility indifference curve, while it is the reverse in the 'signalling' case.

Let us go through some thought experiments to delineate the structure of the axioms which are required to define the notion of renegotiation proofness. Take the example of a monopolist selling a divisible good to a customer who has one of two different valuations for the good. Contracts specify price and quantity. The standard principal agent result would be that the principal offers two separating contracts. One is taken only by the type with the high valuation (H-type) and this contract is efficient. If the transfer enters the utility function additively, this implies that marginal utility equals costs of production (the 'no distortion at the top' result). The other contract is designed for the type with the lower valuation (L-type). Here both price and quantity are smaller. More importantly, the quantity is inefficient small, that is the marginal utility of the L-type is larger than marginal cost. However, if the agent only chooses the contract if he is the L-type, after signing the contract the principal and the agent could agree on a better

[7]Similar arguments and results hold if the principal faces a population consisting of different types instead of only one agent. In that case, the definition of feasibility given later changes slightly. Asheim and Nilssen (1997) use this approach for two groups in society in the context of an insurance provider.

[8]We use the notion of final outcomes, renegotiation proof outcomes and equilibrium outcomes interchangeably. These denote all the possible contracts which could be executed in the end and the corresponding type profiles.

deal, namely to move to a more efficient contract. We would probably conclude that the original contracts cannot have been the final ones.

What about a pooling or partial pooling contract? Suppose there is one contract which is taken by the agent if he is of the L-type and sometimes if he is a H-type. Assume that, starting from this, one can find two new contracts, one of which will be better for each type of agent, and with which the principal makes larger expected profit. At first glance this would lead us to conclude that the former outcome could not have been an equilibrium outcome. However, in general this separating only works if the contract designed for the low valuation type is inefficient. From the arguments given above, we observe that an inefficient contract for only one type cannot be the final one. So both parties would anticipate that the contract will not be the final word spoken. Thus it is not clear whether the two types will indeed separate, as a high valuation type might rationally choose the contract for the low valuation type and expect profitable renegotiation. The problem we face here is that it is not sufficient to argue that profitable negotiation from a given contract to *any* pair of contracts could take place, as these may well be not the final contracts chosen.

To avoid this problem we claim that the parties will only consider renegotiating to any set of contracts and corresponding type-profiles which are themselves final outcomes, so that there is no risk of further renegotiation. This is the method used in Greenberg (1990) and Asheim and Nillsen (1997). It is very close to the Coalition Proof Equilibrium of Kahn and Mookherjee (1995) and Lacker and Weinberg (1993), which uses that an "equilibrium allocation (can) be unblocked only by credible deviations".[9]

We will now discuss the formalisation of this idea.

Formally, let the utility function of the principal be $v(\omega, \theta_i)$, where $\theta_i \in \{\theta_1, \theta_2, ..., \theta_n\}$ is the unobservable type of the agent and $\omega = (\omega_1, \omega_2)$ denotes the contract. (ω_1, ω_2) might be premium and indemnity, quantity and price, level of education and wage, etc.. Agent i's utility is denoted by $u(\omega, \theta_i)$. The ex-ante probability that the agent is of type i is μ_i^0.

Outcomes of the bargaining process are denoted as groups: $G = (\omega, \mu)$ where ω is the contract offered and $\mu = (\mu_1, \mu_2, ..., \mu_n)$ is the type-profile of the agents who choose this contract. It must hold that $\sum_i \mu_i = 1$. Denote by $\pi(G) = \sum_i \mu_i v(\omega, \theta_i)$ the expected utility of the principal when contract ω is executed, and the belief of the type-profile is μ. As many models in the literature assume that the principal is risk neutral we will in

[9] This is also in line with the stable set concept developed by von Neumann and Morgenstern (1941).

the following call the expected utility the profit of the principal.

The type-profile is the revised belief of the principal of the type of the agent after the agent has chosen this contract. For final outcomes, this belief has to coincide with the real type-distribution. For example, in the monopolist example given above, a possible group could be any contract which specifies a price and a quantity and a type profile $\mu = (\mu_H, \mu_L)$ with $\mu_H + \mu_L = 1$. In the case of only one type choosing this contract either μ_H or μ_L is zero and the other is one, i.e. the principal is sure that only the agent of type L (or H) has chosen this contract.

Starting from a group G, by negotiating a new contract menu can be reached. Different types choose appropriate contracts which leads to several new groups G^k. A particular type might in equilibrium employ a mixed strategy and choose more than one contract, if those contracts yield the same utility. Some contracts might be chosen by only one type, some by more than one type. If the single crossing property holds, two different types will at most choose one contract together.

The final groups are negotiated starting from some G, and accepted by the principal and the agent. For consistency, they have to satisfy several constraints. These are given in the following definition, which just says that any outcome must be feasible to reach:

Definition 1 Feasibility
We call the outcomes $(G^1, G^2, ..., G^m)$, with $G^k = (\omega^k, \mu^k)$ starting from $G = (\omega, \mu)$ feasible, if the following constraints are satisfied:

(i) *Bayesian Consistency*
There exists a probability vector $p = (p_1, p_2, ..., p_m)$ with $\sum_k p_k = 1$ such that $\forall i \quad \sum_k p_k \mu_i^k = \mu_i$.

(ii) *Incentive Compatibility*
$u(\omega^k, \theta_i) > u(\omega^l, \theta_i) \Rightarrow \mu_i^l = 0$

(iii) *Agent's Individual Rationality*
$\forall i \text{ with } \mu_i > 0 \;\; \exists k \;\; u(\omega^k, \theta_i) \geq u(\omega, \theta_i)$

(iv) *Principal's Individual Rationality*
$\sum_k p_k \pi(G^k) \geq \pi(G)$

Feasibility implies that starting from contract ω and type-profile μ, every type of agent prefers some of the proposed contracts ω^k, and chooses among those which yield the highest utility for himself, and also the principal is not worse off. Condition (i) ensures that the new type distribution among the set of contracts $\{\omega^1, \omega^2, ..., \omega^m\}$ is consistent with the information that the type profile in the initial group G was μ.

Not all feasible outcomes are renegotiation proof. Let $X(G)$ denote the set of all feasible outcomes, which is not empty, as $G \in X(G)$. Define by $\sigma(G) \subseteq X(G)$ a possible set of renegotiation proof or final outcomes.[10] Let $\mathcal{G} = \{G' | G' \in \sigma(G')\}$ denote all final outcomes for some σ. It might be that there are more than one σ which will satisfy the following conditions. Then we say that an outcome G' can be a possible final outcome if there exists at least one σ which satisfies the following constraints and has $G' \in \sigma(G')$. By definition it most hold that $\sigma(G) = \cup_m \{\mathcal{G}^m \cap X(G)\}$ where $\mathcal{G}^m$ is the m-fold Cartesian product of $\mathcal{G}$.

Following the arguments presented, for σ to be a meaningful concept it has to satisfy two requirements: First, if the negotiation is at any group G, then there must exist a feasible and renegotiation proof outcome which makes noone worse off. This is formalised by:

Definition 2 External Stability

$$\forall G \quad \sigma(G) \neq \emptyset$$

Note that we have defined $\sigma(G)$ to be a subset of $X(G)$ which are all feasible sets.

On the other hand, if a group is to be renegotiation proof or final, at least one of the two parties should not have an incentive to negotiate to any other final outcome. In the present case, it suffices to assume that no other feasible final outcome should give the principal a larger profit based on the information revealed. Formally:

Definition 3 Internal Stability

$$G \in \sigma(G) \quad \Rightarrow \forall (G^1, G^2, ..., G^m) \in \sigma(G) \quad \sum_{k=1}^{m} p_k \pi(G^k) \leq \pi(G)$$

If the two parties agree on a set of possible final outcomes, then these two requirements have to be satisfied if these outcomes are consistent with the possibility of renegotiation. A final outcome can only be considered renegotiation proof, if there do not exist other final outcomes which are feasible and make the principal better off. Otherwise both parties would rationally anticipate that the principal will renegotiate to those new final

[10]In Greenberg and Asheim and Nilssen, σ is called a *standard of behaviour*.

groups. On the other hand, for any other outcome, the two parties will renegotiate to a set of final outcomes, which do not make anyone involved worse off.[11] Note that to be precise, we should have included in the definition of internal stability, that if all agents are not made strictly better off by renegotiation, then they can also block negotiation taking place. However, due to the single crossing property, this can only hold if μ is such that there is a single type of agent. And in that case, as we show below, only fully efficient contracts are renegotiation proof anyway. So we do not limit ourselves by focussing on the incentives of the principal only.

The stability concepts are very similar to a Nash equilibrium in a non-cooperative infinite bargaining game with zero discounting: External stability implies that from every conceivable stage in the negotiation procedure, a well defined outcome will be reached. Due to internal stability, once a final outcome is reached, the parties will not renegotiate further, even if this is costless.

External and internal stability is defined in such a way that renegotiation proof outcomes have to be compared with each other. It does not provide us with a mechanism to construct stable outcomes, it only helps us to verify that if there is a potential candidate for a stable σ, whether this indeed satisfies the stability constraints. It would be helpful to have some knowledge on the types and structure of renegotiation proof outcomes, and those which are not, independent of the particular σ. This will be given in the following two Theorems.

Theorem 1

A necessary condition for a group to be renegotiation proof, is that there does not exist a contract which is feasible and yields larger profit to the principal. Formally:

$$\forall G = (\omega, \mu) \;\; [\exists G' = (\omega', \mu) \in X(G) \;\; \text{s.t.} \;\; \pi(G') > \pi(G)] \Rightarrow G \notin \sigma(G)$$

Proof:

Assume there exists a σ such that $G \in \sigma(G)$. It must be that $G' \notin \sigma(G')$, otherwise internal stability is not satisfied. Thus by external stability there exists $(G^1, G^2, ..., G^m) \in \sigma(G')$. As these are feasible groups, it must hold that $\sum_k p_k \pi(G^k) \geq \pi(G')$. If the contracts $(G^1, G^2, ..., G^m)$ have been feasible starting from G' they must also have been feasible starting from G. As $\sum_k p_k \pi(G^k) \geq \pi(G') > \pi(G)$ internal stability gives us the desired result. QED

[11] In this point we disagree with Asheim and Nilssen (1997) who define external stability in such a way that for an outcome to be non-final there must exist a set of other feasible outcomes which lead to a strictly positive profit for the principal.

Remarks:

(i) The condition in Theorem 1 is equivalent to saying that there does not exist a pooling contract which is strictly better for everyone. Because if there exists a feasible contract which gives the principal a strictly larger profit than there also exists a contract which is strictly better for everyone and vice versa.

(ii) This result would also be expected from a non-cooperative bargaining model: If the principal could offer one contract which all agents, independent of type, prefer, and also the principal is better off, she would do so. Only if a menu of contracts will make all parties better off, the principal has to be careful to consider the strategic incentives the agent has in revealing his type by choosing a particular contract. If only one contract is on offer, those strategic effects do not exist.

(iii) One consequence of this result is that separating contracts will not exist in equilibrium if they are based on inefficient contracts. One example for this is the partial insurance contract a low risk type obtains. Or a price quantity contract where the customer's marginal valuation for the good is larger than marginal costs. In all these cases, the outcome is a group with type profile $(0, ..., 0, 1, 0, ..., 0)$ for which a *single* better contract can be found.

(iv) This result is in disagreement with the results by Beaudry and Poitevin (1995). They obtain even for possibly infinite rounds of negotiation that separating contracts which are inefficient for one type can be sustained in equilibrium. This cannot hold in our framework. As already discussed in the beginning, it seems to be a worthwhile and necessary task to investigate how far their results are a consequence of the specific setup of their game.

(v) Following remark (iii) any negotiation will lead to at most n completely separating contracts. If the single crossing property holds, at most $n-1$ (partial) pooling contracts are possible, so that the size of the final contract menu is limited to $2n-1$. In general, however, it is not possible to find separating contracts which are all efficient, so that the number of outcomes starting from some G will be lower than $2n-1$.[12]

(vi) In the context of a monopolist selling an indivisible good to customers with unknown valuation we have shown (Wambach, 1999) that the condition in Theorem 1 is also sufficient for renegotiation proof outcomes. Asheim and Nilssen (1997) obtain the same result in the special case of an insurance market with two risk types whose utility functions have constant relative risk aversion. However, as we will see in the next

[12] Note that different σ's may lead to different $2n-1$ contracts.

section, in general this condition is not sufficient for renegotiation proof outcomes.

For the next Theorem we first need a definition of efficient outcomes:

Definition 4 *A group is called efficient, if any other set of contracts makes someone worse off, i.e.* $X(G) = \{G\}$.

Theorem 2

For any stable σ*, every efficient group* G *is renegotiation proof:* $G \in \sigma(G)$.

Proof:

This just follows by external stability, if G is the only element in $X(G)$, then G must be in $\sigma(G)$. QED

This was to be expected, however as we will see in the next sections, this result allows us to uniquely pinpoint the possible outcomes of a principal agent problem with private values and common values of the Spence type.

3 Private values

In the private value case the utility of the principal only depends on the contract, not on the type of agent. One example is the monopolist selling different quantities (or qualities) of a good to different types. Independent of who buys the good, costs of production are the same. Private values are only interesting in screening models, where the principal wants to distort 'lower' types (see below) to increase her profit. In signalling models, where the agent makes the offer, the agent would always choose that contract which maximizes his utility and gives zero profit to the principal.

To be precise, we make the following assumption:

Assumption 1

(i) $v(\omega, \theta) = v(\omega) = v(\omega_1, \omega_2)$

(ii) $v_1(\omega_1, \omega_2) < 0,\ v_2(\omega_1, \omega_2) > 0$

(iii) $\forall i \quad u_1(\omega_1, \omega_2, \theta_i) > 0,\ u_2(\omega_1, \omega_2, \theta_i) < 0$

(iv) $\forall i < j \quad -\frac{u_2(\omega_1,\omega_2,\theta_i)}{u_1(\omega_1,\omega_2,\theta_i)} > -\frac{u_2(\omega_1,\omega_2,\theta_j)}{u_1(\omega_1,\omega_2,\theta_j)}$

(v) $v(\omega_1, \omega_2)$ *and* $u(\omega_1, \omega_2, \theta_i)$ *are quasiconcave functions in* (ω_1, ω_2).

Part (i) says that we are in the private value situation. Part (ii) and (iii) imply that the principal prefers smaller values of ω_1 and larger values for ω_2, while it is the reverse for the agent. ω_1 can e.g. be the quantity, while ω_2 is the price of the good. Part (iv) is the single crossing property. Agent types are ordered in such a way that for each contract the indifference curve of 'lower' types is steeper. This implies that the principal prefers agents with larger types. Finally, (v) is a sufficient condition for the existence of optimal contracts.

If the principal knows the type of the agent (θ_i), then a unique optimal contract for every utility level ($\bar{v}$) of the principal exists. Diagrammatically, this is given where the agent's indifference curves are tangential to those of the principal. Call these contracts $\Omega(\bar{v}, i)$. Theorem 2 tells us that all these contracts have to be renegotiation proof in any σ. For two types (L and H), these contract curves are shown in figure 1.[13]

Figure 1 around here

The principal prefers contracts which lie to the northwest, while the agent prefers those which lie southeast. The two lines L and H denote the set of optimal contracts. Note that the contract curve for the L type lies to the left of that H type. In the one period principal agent model, the principal would offer two contracts of the type l_1 and h_1 (see figure 1), which have the property that the contract for the high type is efficient, the high type is indifferent between his contract and that for the low type, and the low type just receives his outside option utility. The exact position of the contracts depends on the distribution of types. It may well be the case that agent L is not served at all, i.e. $l_1 = (0, 0)$. As mentioned above, in a screening model, the agent would offer the efficient contract dependent on his type which yields zero utility for the principal. In figure 1 these are denoted by l_2 and h_2.

If renegotiations are allowed, this result is different:

Proposition 1

Under Assumption 1, in any stable σ the principal can only offer separating contracts which lie on the efficient contract curves.

[13]For easier understanding we draw in this and the following figures the indifference curves of the principal as straight lines, and denoted by P. The indifference curves of the agent are denoted U_L and U_H respectively. The efficient contract curves are denoted L and H.

Proof of Proposition 1:
We prove the Proposition for two types only, but the extension to any finite number of types is straightforward.

There are only two types of possible final outcomes. Either the principal knows the type of the agent or not. In the first case the outcome is fully revealing (perfect screening), in the latter the principal has some belief on the type of the agent. The proof proceeds in two steps. First we show that all renegotiation proof outcomes of the first type have to lie on the efficient contract curve, and second, we show that no renegotiation proof outcome of the second type exists, i.e. there can be no pooling.

The first part is simple. Say the agent is of the low type in the revealing outcome. Then such a group can be written as: $G = \{\omega, (1, 0)\}$, that is the contract signed is ω, while the belief of the type distribution is such that the agent is of type L for sure. Theorem 1 tells us, that if there exists a single contract which makes everyone better off, than this group cannot be a final outcome. But this holds for all contracts apart from the efficient ones $(\Omega(\bar{v}, L))$. Therefore at most the efficient contracts can be possible candidates for fully revealing renegotiation proof groups. Theorem 2 tells us, that indeed in any σ these are final outcomes. Note that this result easily generalizes to more than two types.

Let us now turn to the second part. Consider any group $G = \{\omega, (\mu, 1-\mu)\}$, where the contract is given by ω while the principal has the belief that the agent is of type L (H) with probability μ $(1-\mu)$. To show that this cannot be a renegotiation proof outcome, it is useful to consider figure 2, where the contract space is separated into three regions: A, B and C. Region A lies to the left of both efficient contract curves, region B in between and region C to the right.

Figure 2 around here

Consider any contract in region A (e.g. a): At this point the indifference curve of the principal is steeper than those of both types of agents, as this lies to the left of both optimal contract curves. So there exists a single contract which makes everyone better off (e.g. a'). Following Theorem 1, a pooling outcome with contract a cannot have been a final outcome. The same argument holds for contracts in region C (e.g. c), where the indifference curve of the principal is flatter than those of both agents. Also here there exists a single contract which is better for everyone (c'), therefore this outcome cannot be renegotiation proof. Finally consider outcomes in region B (e.g. b). For any of those contracts the indifference curve of the principal is steeper than the high type indifference curve, but flatter than that of the low type. From this point, negotiating towards two contracts of type b_l, b_h where all L types choose b_l, all H types choose b_h is feasible and will make the principal better off. As we know that all efficient fully revealing groups are in σ, a group with contract b cannot be: This would violate internal stability. QED

This Proposition shows that the principal cannot distort agents. All final contracts have to fully screen the market and lie on the efficient contract curve for each type. In the two type case in a screening model, the best possible contracts from point of view of the principal are given by l_3 and h_3, i.e., she can at best give an efficient contract to the low type with zero utility for him, and then the best possible efficient contract to the high type. In contrast to the standard principal agent models, this result does not depend on the distribution of types.

The generalization of this result to many types is straightforward: The principal would prefer to distort the lower types towards region A. This does not work as one can find a single contract which makes everyone better off. Regions like B and C in figure II are never considered by the principal in the first place, from here it is always better to either split the groups (in B) or to move to the southwest (in C), without violating any incentive constraint.

This result can be considered as a generalization of the Coase Conjecture. In the Coase conjecture a monopolist cannot keep prices high, as she is always tempted to lower the prices after the high valuations and low valuations have revealed themselves. Also here, the principal cannot refuse to renegotiate if the agents have revealed some information about their type. However there is one difference: In the bargaining problem it can be shown that under some circumstances the monopolist can earn her monopoly profit (Ausubel and Deneckere, 1993, Wambach, 1999). This does not hold here. The principal cannot achieve the same profit as if distortion were possible. To obtain distorting contracts, two features have to be satisfied: First, efficient contract curves should be the same for different types. In the bargaining game, for all buyer types with valuation above costs trade (at any price) is efficient, while for those with valuation below costs, no trade (at any price) is efficient. Second, there must exist a buyer's type with valuation equal to the cost of the seller, so that for this type both trade and no trade is efficient. Both properties are necessary and sufficient to obtain distorting contracts in equilibrium. In short, this is achieved in the following way: By charging the monopoly price, some buyer types will not buy the good. Now σ is defined such that the only final groups one might negotiate to are those where the seller charges price equal to her costs. But this leads to zero profit, which is the same as she obtains from the non-buyers. So internal stability is not violated.

In the principal agent model discussed here this is different, because the possibility to screen along a further dimension allows the principal to treat agents differently, which in turn *weakens* her bargaining position.

As the Coase conjecture implies that there is less need to worry about durable good monopolies, this Proposition shows that in the private value case there is even less to worry about the bargaining power the principal has, as the fully efficient outcomes are the only possible outcomes.

This result generalizes to some, but not all situations with common values, to which we turn now.

4 Common values

In this section the utility of the principal does not only depend on the contract but also on the type of the agent who chooses this contract. Two famous examples are the Spence signalling model (1973) and the Rothschild and Stiglitz (1976) (and Stiglitz 1977) insurance model. In the first example, agents differ in their productivity, while in the latter agents have different risk probabilities. Both features make the profit of the principal dependent on the agent's type. These two examples are also useful in another respect: Following Beaudry and Poitevin (1993), these examples describe the different common value cases. Call the first the Spence (S) case, the latter the Rothschild-Stiglitz (RS) case. As described above, the two cases differ in the ranking of marginal trade offs by the principal and the agent. Resulting from this, there is another difference between those cases: Due to the 'no distortion at the top' result , there always exists one type who does not get distorted, both in signalling and screening models. In common values of the S type, it is the low type who is 'at the top' in the signalling model, while it would be the high type who is not distorted in a screening model. In the RS case, it is always the same type, namely the high risk type, who is 'at the top' and therefore does not receive a distorting contract.

Also in our approach, the outcomes in these two cases differ considerably - while in the S case, the same result as in the private value case is obtained, i.e. no distorting contracts are possible, in the RS case, distorting, but pooling, contracts can exist in equilibrium.

4.1 The 'Spence' case

In the S case, the following assumption is required in addition to Assumption 1, (ii)-(v):

Assumption 2
(i) $v(\omega, \theta) = v(\omega_1, \omega_2, \theta)$
(ii) $\forall i < j \quad -\frac{v_2(\omega_1,\omega_2,\theta_i)}{v_1(\omega_1,\omega_2,\theta_i)} < -\frac{v_2(\omega_1,\omega_2,\theta_j)}{v_1(\omega_1,\omega_2,\theta_j)}$

In the common value of the S case, the indifference curves of the principal for larger types are stepper than those for lower types. In Spence education model, for example, the low type has larger costs of providing more effort, thus the 'L' type indifference curve is steeper than that of the 'H' type (Assumption 1(iv)). At the same time, the additional productivity through more education of the low type is smaller than of the high type, therefore the indiffernce curves of the principal are steeper for the higher types.

From Assumption 2(ii) it follows that for any contract the principal prefers higher types:

$$\forall \omega \quad \forall j > i \quad v(\omega_1, \omega_2, \theta_j) > v_2(\omega_1, \omega_2, \theta_i)$$

Under this assumption, it is easy to see that the efficient contract curves $\Omega(\bar{v}, i)$ do not cross, and if $i < j$, then $\Omega(\bar{v}, i)$ lies to the left of $\Omega(\bar{v}, j)$. This holds, because if $j > i$

$$-\frac{v_2(\omega_1,\omega_2,\theta_i)}{v_1(\omega_1,\omega_2,\theta_i)} = -\frac{u_2(\omega_1,\omega_2,\theta_i)}{u_1(\omega_1,\omega_2,\theta_i)} \quad \Rightarrow \quad -\frac{v_2(\omega_1,\omega_2,\theta_j)}{v_1(\omega_1,\omega_2,\theta_j)} > -\frac{u_2(\omega_1,\omega_2,\theta_j)}{u_1(\omega_1,\omega_2,\theta_j)}$$

as a consequence of Assumption 1(iii) and 2(ii).

In Figure 3 the optimal second best contracts for two types are shown. Here the different zero profit levels for the two types are denoted by P_L and P_H. For the screening model, the outcomes are the contracts l_1 and h_1, while for the signalling model they are l_2 and h_2. In the signalling case, the high type gets distorted (e.g. by providing more education), while in the screening case, the low type gets distorted.[14]

Figure 3 around here

[14] The results about the signalling case only hold under the appropriate belief refinements.

If renegotiation is allowed, distortion cannot be possible. This is shown in the following Proposition:

Proposition 2

If Assumption 1(ii)-(v) and 2 are satisfied, then in any stable σ the outcome can only be separating contracts which lie on the efficient contract curves.

Proof:
The proof is again done diagrammatically and for two types only. As before, the generalization to more than two types is straightforward. Consider Figure 4, where as before we have split the contract space in three regions, A which lies to the left of both efficient contract curves, B which lies in between these two curves, and C which lies to the right.

Figure 4 around here

As before, we claim that no contract of type a, b or c can be renegotiation proof. At a, the indifference curve of the principal for the L types is steeper than the L types indifference curve. As the L type indifference curve itself is steeper than the H type indifference curve, while the indifference curve of the principal for H types is steeper than for L types, there must exist a single contract (a') which makes everyone better off. This violates the condition of Theorem 1, therefore no contract in region A can be a final one. With a similar generalization of the proof of Proposition 1, contracts in region B and C can be discussed (see Figure 4). Therefore only separating efficient contracts are renegotiation proof. QED

Also in this case a generalized Coase conjecture holds - neither the principal can increase her profit by distorting lower types agents (as she does in screening models), nor can the higher types agents gain larger utility by distorting themselves (like in signalling models). In the Spence education model, for example, if education only serves as a signal and has no productive value at all, then the efficient contract curves of all types lie on the ω_1-axis, i.e. zero education. This line then describes the set of possible final outcomes, where, dependent on who has the bargaining power, either the contract with average productivity, or that with the reservation wage may be chosen.

But again, this result only holds if education and wage are bargained over. If education is chosen before wage bargaining takes place, then the inefficiencies have already occured, and the standard signalling may take place. However, in many models it is assumed that the two-dimensional contract is negotiated over. In those cases, our results apply.

In all these models described so far, by allowing to renegotiate one party gains and the other loses, so the mere possibility of renegotiation has no direct negative welfare effect. This may be different in the next subsection, where common values of the RS type are discussed.

4.2 The 'Rothschild-Stiglitz' case

In the RS case,the condition of Assumption 2(ii) has the opposite sign:

Assumption 3
$\forall i < j \quad -\frac{v_2(\omega_1,\omega_2,\theta_i)}{v_1(\omega_1,\omega_2,\theta_i)} > -\frac{v_2(\omega_1,\omega_2,\theta_j)}{v_1(\omega_1,\omega_2,\theta_j)}$

In the Rothschild Stiglitz model, for example, higher types have larger risk probability, therefore their indifference curves are steeper than those of the lower types (Assumption 1(iv)). On the other hand, a marginal increase in indemnity is more costly for the higher types than for the lower types, therefore the indifference curves of the principal are stepper for the lower types.

Assumption 3 then implies that for every contract the principal prefers to deal with the lower types:

$$\forall \omega \ \ \forall j > i \quad v(\omega_1, \omega_2, \theta_j) < v_2(\omega_1, \omega_2, \theta_i)$$

In contrast to the last case, the efficient contract curves for the different types may now cross each other, and no clear ordering is possible. In the standard second best screening world with two types, this even allows for a distortion of both types if the efficient contract curve of the L type lies to the right of the H type.

The standard second best contracts for two types, where the efficient contract curve of the L type lies to the left of the H type, are shown in Figure 5.

Figure 5 around here

Both in the signalling and screening model, it is the low type who gets distorted. In the case of an insurance market, this is the low risk type, as was shown by Rothschild and Stiglitz (1976) in a context similar to a signalling setup[15] and by Stiglitz (1977) in a screening model. (See contracts l_1, h_1 for the screening model, and l_2, h_2 for the signalling model.)

If renegotiations are allowed, then the procedure used in the proofs of the previous Propositions does not work. There are contracts in region A and C for which no single better contract exists. This can be the case if at some contract the indifference curve of the principal for the high type is flatter than the low type indifference curve (see Figure 6, contract a). If for such a contract a group has a type profile with many H types, so that the pooling profit line is also flatter than the L type indifference curve, no single better contract exists. Here, the pooling profit line is defined such that along this line the principal is indifferent between any contracts, given that the agent has a type distribution μ.

Figure 6 around here

In the case of an insurance market, for example, if a group contains a contract with a deductible and has a type distribution which is such that the indifference curve of the low risk type is steeper than the pooling line along which the principal for the given type distribution obtains the same profit, then no single contract exists which makes everyone better off.

Not only does the proof of the previous Propositions not work in this case, it also holds that if a stable σ exists, then in some cases groups have to be renegotiation proof whose contracts do not lie on the efficient contract curves.

In the case where the efficient contract curves for lower types do not lie to the right of the contract curves for higher types, this is shown in the following proposition:

Proposition 3 *Given Assumption 1(ii)-(v), 2(i) and 3, and let the efficient contract curve of the lower types lie to the left of the larger types, i.e.,* $\forall i < j$, $\forall \omega \in \Omega(\bar{v}, i)$ $\exists p \geq 0$ $s.t.(\omega_1 - p, \omega_2) \in \Omega(\bar{v}, j)$.

Then, either only efficient separating contracts are renegotiation proof, or there exists renegotiation proof groups with contracts which do not lie on any efficient contract curve,

[15] Rothschild and Stiglitz consider a competitive market. The outcome is the same as if in a principal agent setup the informed agent would make a take-it-or-leave-it offer to the principal who has the appropriate beliefs for out of equilibrium offers.

i.e.,

$$\forall \sigma \quad \exists G = (\omega, \mu) \in \sigma(G) \quad \text{s.t.} \quad [\forall i \ \forall \bar{v} \quad \omega \notin \Omega(\bar{v}, i)].$$

For such a group, μ has to be non-degenerate, i.e. $\forall i \quad \mu_i < 1$.

Proof:
The precise proof for any number of types is rather messy and not very instructive, so we go through the arguments for two types only.

There are three cases: First, for all groups, negotiating towards efficient separating contracts is feasible and strictly profitable for the principal. Second, such a negotiation is feasible, but not always strictly profitable for the principal. Third, there exists a group for which negotiation to efficient contracts is not feasible. We show that in case 1, only efficient outcomes are in σ. Case 2 does not exist while in case 3, some final groups must contain contracts which do not lie on the efficient contract curves.

Consider case 1: If for any group $G = (\omega, \mu)$ negotiation towards efficient separating contracts is feasible and profitable for the principal, and by Theorem 2 we know that those groups are final outcomes, then by internal stability these groups are indeed the only groups which are in σ.[16]

In case 2 for most groups negotiation towards efficient separating contracts is possible, but there exist one or more groups for which negotiation gives the principal the same profit, but not less. Such a group must have positive probability for both types, otherwise negotiation towards efficient contracts leads to positive profits. Furthermore, this group either lies in region A or C. But consider a group with the same contract, but a type distribution which has the probability of the high type (if the contract lies in A) or the low type (if the contract lies in C) increased. For such a group, a negotiation towards efficient separating contracts must be worse for the principal, which contradicts the assumption.

In case 3 there exists one group for which negotiation towards the efficient separating contracts is not feasible. Then by external stability either this group is itself in σ or there exists other feasible groups, which are in σ. Such a group is either a contract of type a or of type c in figure 6. Consider type a: For any final group it must hold that the contract which the L type chooses lies to the left of the efficient contract curve $\Omega(\bar{v}, L)$.

From Theorem 1 it follows that these groups cannot be fully revealing, which completes the proof. QED

[16] In the Appendix we discuss when such a result may hold.

An example for a situation where distorting contracts have to occur in equilibrium, is the following: Consider again the insurance market. The efficient contracts are those which provide full insurance. Starting from a no-trade situation, the principal would only accept a contract where the premium is larger or equal to the pooling premium. However, it might well be that the low risk type prefers to stay uninsured rather than to buy full insurance for the pooling premium. In that case, distorting pooling contracts have to be offered and accepted in the negotiation.[17] It is interesting to note that this problem arises for opposite reasons than the non-existence of the Rothschild-Stiglitz equilibrium. In their model, if the proportion of high risks is small, which shifts the zero profit pooling line towards the zero profit line of the low risks, the equilibrium breaks down. In our case, if the proportion of high risks is large, which shifts the pooling line in the opposite direction, an efficient outcome may not be possible and distorting contracts occur.

Let us now turn to the existence of σ. In the Appendix we show the existence for the commonly used case of two types where one parameter enters the utility function additively, i.e. $u(\omega, \theta_i) = f(\omega_2, \theta_i) + \lambda_i \omega_1$, and $v(\omega, \theta_i) = g(\omega_2, \theta_i) - \omega_1$. The proof draws heavily upon the work by Asheim and Nilssen (1997), who have shown existence in the case of an insurance market, where both agents have constant relative risk aversion.[18]

In contrast to the private value case and the common value case of the S type, here it can happen that no one gains from the possibility to renegotiate. Consider the insurance market again: The best possible outcome for the principal in the screening case is to offer two contracts: One with full and the other with partial insurance: In contrast to standard models, the high risk type mixes between the two, while the low risk type chooses the partial insurance. The mixing is such that at the partial insurance contract, the indifference curve of the low risk type is tangential to the pooling indifference curve of the principal. It might well be that both the principal and the high risk type are better off if renegotiation were forbidden, while the low risk type receives zero utility in any case.

[17]Note that only offering a full insurance contract to the high risks at the fair premium is not possible, as this implies that the low risk type receives no contract, from which renegotiation is again possible.

[18]As mentioned above, Asheim and Nilssen use a somewhat stronger definition of external stability. Thus their results are also valid in our case. We differ in our proof in the following respects: First, in the insurance market the efficient contract curves lie on top of each other, while we consider the case where they are separate and in ascending order. Second, Asheim and Nilssen restrict their contract space by excluding overinsurance a priori, i.e., contracts in region C, which we do not.

5 Summary and Conclusions

In this paper we have provided an axiomatic approach to the problem of immediate renegotiation. In this approach a necessary condition for any possible final outcome could be obtained: For any contract and corresponding type profile which is renegotiation proof there does not exist a *single* contract which is preferred by everyone.

Furthermore, any efficient group, that is an outcome for which even under perfect information no better set of contracts exists, has to be renegotiation proof.

These two general results allow us to show that in the private value case, only separating contracts which are fully efficient can be the outcome. Thus the principal-agent 'problem', where the principal distorts the agent to obtain a larger profit, ceases to exist.

This result generalizes to the common value case of the Spence type.

Only for common values of the Rothschild-Stiglitz type are distorting contracts possible and sometimes also necessary. But in contrast to standard models, these contracts have to be of the pooling type. The existence of a stable set of renegotiation proof outcomes for a special case is proven, while the general existence remains to be shown.

Appendix

In this appendix we prove for a special case of common values of the RS-type the existence of a stable σ. The proof draws heavily upon the proof of Proposition 2 in Asheim and Nilssen (1997). It differs in the following two respects: First, Asheim and Nilssen consider an insurance market, so that the efficient contract curves for the L and the H type are the same. Here the case where $\Omega(\bar{v}, L)$ lies to the left of $\Omega(\bar{v}, H)$ is considered. Following from this, the construction of renegotiation proof outcomes differs slightly. Second, Asheim and Nilssen assume that no overinsurance takes place, i.e. the region in contract space to the right of $\Omega(\bar{v}, H)$ is excluded by assumption. We include this region in our proof.

We need the following assumption:

Assumption 4

(i) $u(\omega, \theta_i) = f(\omega_2, \theta_i) + \lambda_i \omega_1.$

(ii) $v(\omega, \theta_i) = g(\omega_2, \theta_i) - \omega_1$

(iii) For $i < j$ *and* ω_2 *s.t.* $-f_1(\omega_2, \theta_i)/\lambda_i = g_1(\omega_2, \theta_i)$ *it holds:*
$-f_1(\omega_2, \theta_j)/\lambda_j < g_1(\omega_2, \theta_j)$

Additivity of ω_1 implies that the efficient contract curves are vertical lines. Assumption (iii) guarantees that the line for the H type lies to the right of the L type.

As only two types are considered, a group G can be denoted as $G = (\omega, p)$ where p is the probability of the L type.

A stable σ is constructed in the following way. First, all efficient groups are in σ, i.e. $G = (\omega, p)$ with $\omega \in \Omega(\bar{v}, \theta_i)$ and $p = 1$ if $\theta_i = L$, $p = 0$ if $\theta_i = H$.

Second, consider the contracts in region A, i.e. to the left of the contract curve $\Omega(\bar{v}, L)$ (which is denoted as L in figure 7).

Figure 7 around here

Take any indifference curve of the L-type. There exists a single efficient contract on $\Omega(\bar{v}, L)$ where this indifference curve crosses the contract curve. Call this contract 0_l, and the according group $G_0 = (0_l, p_0)$ with $p_0 = 1$

For contract 0_l there exists a single contract $0_h \in \Omega(\bar{v}, H)$ which solves $u(0_l, H) = u(0_h, H)$. This defines $G_0^h = (0_h, p_0^h)$ with $p_0^h = 0$.

Going along the L type indifference curve, for the first contracts (before a, see figure 7) negotiations towards 0_l and 0_h is profitable for any type distribution. At a, the principal achieves the same profit with the H types as she would at contract 0_h. Now going down the indifference curve even further, for any contract there exists a type distribution such that the principal is indifferent between staying there and negotiating to the groups G_0 and G_0^h. These groups define a set:

$$\Gamma^-(G_0) := \{G = (\omega, p) | u(\omega, L) = u(0_l, L),\ p > 0,\ \pi(G) = \eta\pi(G_0) + (1-\eta)\pi(G_0^h),\ \eta p_0 = p\}$$

If we move along the indifference curve of the L type, then p for those groups which are in $\Gamma^-(G_0)$ increases, until we may reach contract 1_l, where the pooling indifference curve of the principal is tangential to the indifference curve of the L type (see figure 7). If no such contract exists, then all groups which are in $\Gamma^-(G_0)$ are in σ and the construction stops. Otherwise, call such a group $G_1 = (1_l, p_1)$. Now, let $G = (\omega, p) \in \sigma(G)$ if $G \in \Gamma^-(G_0)$ and $u(\omega, H) > u(1_l, H)$. As p is increasing along the indifference curve, this construction satisfies internal stability. What about external stability: Take any contract which lies on the indifference curve, i.e. b (see figure 7), and any type profile p. We know that there exists a p_b such that $G_b = (b, p_b) \in \sigma(G)$. If $p > p_b$, then negotiating to G_0 and G_0^h must be profitable. If $p < p_b$, then negotiation to G_b and G_b^h is profitable. Here $G_b^h = (b_h, 0)$ with b_h such that $u(b_h, H) = u(b, H)$ (see figure 7).

Going down the indifference curve even further, we reach contracts like contract c. If a group has a low p_c, then where should this group negotiate to. The best it could do is to negotiate to G_1 and G_1^h where $G_1^h = (1_h, 0)$ (see figure 7). However, it may well be that this negotiation is not proftable for the principal. Therefore we have to construct a similar set of groups as those above:

$$\Gamma^-(G_1) := \{G = (\omega, p) | u(\omega, L) = u(0_l, L),\ p > 0,\ \pi(G) = \eta\pi(G_1) + (1-\eta)\pi(G_1^h),\ \eta p_1 = p\}$$

Again, there may exists a group G_2 with contract 2_l at which the indifference curve of the principal for this type distribution and of the L type are tangential. If not, every group in $\Gamma^-(G_1)$ is in σ. If a G_2 exists, then let $G = (\omega, p) \in \sigma(G)$ if $G \in \Gamma^-(G_1)$ and $u(\omega, H) > u(2_l, H)$. The construction process is then repeated.

With the same arguments as above, for all groups with contracts 'between' l_1 and l_2 and which are not in σ, feasible and renegotiation proof groups exist. Those groups which are in σ are constructed in such a way, that internal stability also holds.

Having defined those groups for a particular utility level of the L type, we now define all those groups to be in σ which satisfy the following condition:

$$G = (\omega, p) \in \sigma(G) \ \text{ if } \exists \lambda > 0 \ \text{ s.t.} G' = (\lambda\omega, p) \in \sigma(G')$$

That is, given any group which is in σ, any other group with the contract along the same vertical line and with the same type distribution is in σ as well. It is obvious, that this does not violate internal stability, because if one cannot find profitable groups along the same indifference curve of the L type, there are surely no profitable groups which give the L type larger utility.

This defines all groups with contracts in region A, which are in σ. In region B no contract belongs to a final group, as negotiation towards two efficient contracts is possible (see e.g. figure 6).

For contracts in region C a similar construction is used, but now starting from a high risk indifference curve, i.e. $G_0 = (0_h, p_h)$ with $p_h = 0$ (see figure 8).[19]

Figure 8 around here

[19]Note that the scaling in figure 7 and 8 differs, with the same scale, indifference curves in figure 8 have to be steeper.

For 0_h, there exists a unique contract 0_l which satisfies $u(0_l, L) = u(0_h, L)$ and which lies on $\Omega(\bar{v}, L)$. Call $G^l = (0_l, 1)$. Then define

$$\begin{aligned} \Gamma^+(G_0) = \quad & \{G = (\omega, p) | u(\omega, h) = u(0_h, h), p < 1, \\ & \pi(G) = (1-\eta)\pi(G_0) + \eta\pi(G^l), (1-\eta)(1-p_h) = (1-p)\} \end{aligned}$$

Here, moving away from the efficient contract curve, decreases p for any group which is in σ. Again, that group where μ is such that the indifference curve of the principal is tangential to that of the high risk type, defines the group G_1 with contract 1_h. If no such group exists, then the process stops and all groups in $\Gamma^+(G_0)$ are renegotiation proof. If it exists, then $G \in \sigma(G)$ if $G \in \Gamma^+(G_0)$ and $u(\omega, L) > u(1_h, L)$. As before this procedure is repeated over and over again. Then finally, all those groups define vertical lines in the contract space along which all the other contracts belong to renegotiation proof groups with the same type distribution.

As above, internal and external stability can be verified. If for a contract b, p is smaller than some p_b (which may well be zero), then negotiating towards groups G_n, G_n^l is profitable, where $n \in \{1, 2, ...\}$. If p is larger than p_b, then negotiating towards the final groups $G_b = (b, p_b)$ and $G_b^l = (b_l, 1)$ where $u(b_l, L) = u(b, L)$ and b_l efficient, is profitable. Internal stability is given, as in any set of renegotiation proof groups where the contracts are such that $u(n_h, L) > u(\omega, L) > u((n+1)_h, L)$ with $n \in \{1, 2, ...\}$ the probability of the low type is decreasing, such no negotiation to the other groups is possible. This completes the construction.

The result can be generalized in two respects: In the case where the curves of the L and the H type overlap, a construction along the lines of Asheim and Nilssen (1997) is possible. Furthermore, this construction also works if the utility function of the agent is homothetic, and that of the principal linear in the contract variables.

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