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Should Contractual Clauses that Forbid Renegotiation Always be Enforced?

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Should Contractual Clauses that Forbid Renegotiation Always be Enforced?

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Recent work in the field of mechanism design has led some researchers to propose institutional changes that would permit parties to enter into nonmodifiable contracts, which is not possible under current contract law. This paper demonstrates that it may well be socially desirable *not* to enforce contractual terms that explicitly prevent renegotiation, even if rational and symmetrically informed parties have deliberately signed such a contract. The impossibility to prevent renegotiation can constrain the principal's abilities to introduce distortions in order to reduce the agent's rent, so that the first-best benchmark solution will more often be attained.

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1 Introduction

Renegotiation is a major issue in the recent economic literature on contracts. While some authors, in particular proponents of the incomplete contracting approach, argue that parties in reality often cannot commit not to renegotiate, others suggest institutional changes that would enable parties to prevent renegotiation.[1] Specifically, some economists working in the field of mechanism design argue that in an ideal world parties should be able to register their contract with the court. Given that the court can commit to enforce contracts, it should then also be able to commit to prevent any renegotiation that has explicitly been ruled out by the parties. The goal of the present paper is to demonstrate that it may well be socially desirable to stick to the current legal practice, i.e. not to enforce clauses that rule out renegotiation, even if institutional changes would make such enforcement practicable.

Of course, it is well known that renegotiation can be beneficial if the parties initially only write a simple, incomplete contract.[2] Such a contract may not be flexible enough to adjust to changing circumstances. However, in such cases the parties would have no reason to include in their contract a term that rules out renegotiation. Hence, the observation that renegotiation may enhance the parties' welfare if the original contract is incomplete cannot explain why courts should not enforce contractual clauses that

[1] See Tirole (1999) for an excellent review of this debate. Hart (1995) emphasizes that renegotiation cannot be ruled out in practice, while Maskin and Tirole (1999) argue that commitment should be possible in an ideal world. In the law and economics literature, Jolls (1997) has recently argued that contract law should enable parties to tie their hands (see also Schwartz and Scott, 2003).

[2] See Huberman and Kahn (1988), who argue that optimal complex contracts may sometimes be substituted by simple, unconditional contracts, when they are renegotiated at a later date. In the law and economics literature, Schwartz and Watson (2004) have recently argued that renegotiation can be beneficial when the costs of writing a complex, complete contract are high.

explicitly forbid renegotiation.

In the present paper, I follow the traditional principal-agent literature and assume that a principal offers a complete contract to an agent. I consider a straightforward variant of the simplest moral-hazard model, where a risk-neutral principal has to motivate a risk-neutral and wealth-constrained agent to exert unobservable effort.[3] The only difference between my model and the standard textbook version is that I analyze a relationship between principal and agent which consists of two consecutive stages. Of course, if there were only one stage, renegotiation would not be an issue.

Two scenarios will be compared. In scenario I, it is assumed that in accordance with the mechanism design ideal the principal can include a non-renegotiation term in the contract that will actually be enforced by the court. In scenario II, it is assumed that in accordance with the current practice, the parties are not permitted to enter into a nonmodifiable contract, so that mutually agreed-upon renegotiation cannot be prevented. It will be demonstrated that the first-best benchmark solution will more often be achieved in scenario II.

At first sight, this result might seem to be surprising. After all, in a complete contracting framework, the fact that non-renegotiation clauses are unenforceable merely imposes an additional constraint on the class of contracts that the parties can write. How can this be beneficial? Recall that the principal's goal is to maximize her expected profit, which equals the total surplus minus the rent that she must leave to the agent in order to induce effort. Hence, the principal is not only interested in enhancing the total surplus, she also wants to keep the agent's rent small. As is well-known, this

[3]See e.g. Laffont and Martimort (2002) for a modern textbook treatment of this standard moral hazard model. It is a building block of several recent papers, see e.g. Crémer (1995), Baliga and Sjöström (1998), Winter (2000), Tirole (2001), Laux (2001), Che and Yoo (2001), and Schmitz (2005).

trade-off implies that the principal will introduce distortions of the induced effort away from its first-best level. Contract law can alleviate these distortions if it constrains the principal's possibilities to reduce the agent's rent. Specifically, the principal will sometimes threaten to implement a low effort level in the second stage only because she wants to reduce the rent that she must pay the agent in order to induce high effort in the first stage. Such threats may be ineffective if renegotiation cannot be prevented.[4]

It should be emphasized that the model does not rely on precontractual private information. It is already known that it can be beneficial if contract law restricts the admissible set of contracts when there is asymmetric information at the contracting stage.[5] The model also does not rely on externalities on third parties.[6] Instead, the driving force in the present paper is the fact that utilities are partially non-transferable due to the agent's wealth constraint. If the agent had unlimited wealth, the parties would always write a contract that maximizes the total surplus, which they could then distribute among them by lump-sum transfer payments. In this case, restrictions imposed by contract law could not be beneficial.

The fact that the extent to which utilities are transferable can be relevant in the context of renegotiation has also been emphasized by Bensaid and Gary-Bobo (1993). Yet, the focus of their paper is quite different. They argue that while contracts with

[4]The model thus supports the view of Davis (2003), who argues that there may be some wisdom in limiting parties' freedom to contract over the scope of freedom to contract itself.

[5]Aghion and Hermalin (1990) show that restrictions of the class of contracts that an informed party may offer can be welfare enhancing, because inefficient signalling may thus be ruled out. Schmitz (2004) shows that job protection laws that forbid employers to dismiss employees can be beneficial in the presence of adverse selection.

[6]It is well known that restrictions of contractual freedom can be beneficial if third parties may be negatively affected by the contract, see e.g. Spier and Whinston (1995).

third parties are not useful as a commitment device if such contracts can be nullified through renegotiation, this might not be the case if utilities are non-transferable.[7]

The rest of the paper is organized as follows. In the next section, the basic model is introduced. The two scenarios are then analyzed in sections 3 and 4, respectively. In section 5, the two regimes will be compared. Section 6 concludes. All formal proofs have been relegated to the appendix.

2 The basic model

Consider two risk-neutral parties, a principal and an agent. At some initial date 0, when the parties are still symmetrically informed, the principal offers a contract to the agent, who has no resources of his own. The reservation utilities of both parties are given by zero. The relationship between the principal and the agent consists of two stages.

In the first stage, the agent can exert unobservable effort $e_1 \in \{0, 1\}$. His disutility of effort is given by $e_1 c$. The verifiable outcome of the first stage may either be a success (yield return $R > 0$) or a failure (yield no return). If the agent works hard, there will be a success with probability p_H. Yet, if the agent shirks, the probability of success is only $p_L = p_H - \Delta p$ (where $p_H > \Delta p > 0$).

In the second stage, the agent can again choose an unobservable effort level $e_2 \in \{0, 1\}$, incurring disutility $e_2 c$. For simplicity, it is assumed that the second-stage technology is identical to the one in the first stage (i.e., the second stage can yield the same

[7] Bensaid and Gary-Bobo (1993) do not analyze whether the law should enable commitment. In their framework, if non-renegotiation clauses were enforceable, contracts with third parties would trivially be useful independent of whether or not utilities are transferable.

return and the success probabilities are again p_H and p_L).[8]

Finally, the principal makes the contractually specified payments to the agent. It should be emphasized that in this paper no ad hoc restrictions on the class of feasible contracts will be made (i.e., there is complete contracting in the sense of Tirole, 1999). Hence, a contract specifies payments from the principal to the agent conditional on the outcomes of the two stages.

Note that it has deliberately been assumed that each relevant variable is either unobservable or verifiable, which is consistent with traditional hidden action models. As has been remarked by Tirole (1999), the "observable but unverifiable" assumption that is prominent in the recent incomplete contracting literature has caused controversial debates, while a modelling consensus has developed around the traditional moral hazard paradigm.[9] Specifically, in the present model a contract is given by a vector $w = (w_{00}, w_{01}, w_{10}, w_{11})$, where $w_{x_1x_2} \geq 0$ is the amount that the agent receives depending upon whether stage $i \in \{1, 2\}$ was a failure ($x_i = 0$) or a success ($x_i = 1$).[10]

As a final piece of notation, let $e = (e_1, e_2(0), e_2(1))$ denote the effort profile that the principal wants to implement, where $e_2(x_1)$ is the second-stage effort given that the outcome of the first stage was $x_1 \in \{0, 1\}$.

The first-best benchmark. Throughout, the analysis will be focused on the

[8]It is straightforward to see that the model could easily be extended to the case in which the technological details are different in the two stages. This would only complicate the exposition and lead to additional case distinctions without yielding further economic insights.

[9]Given complete contracting, the presence of observable but unverifiable variables would imply the necessity to consider "message games" (see e.g. Moore, 1992). In a pure moral hazard framework no such complications arise.

[10]It is straightforward to see that nothing could be gained if additional payments were made at an earlier point in time. It can also easily be seen that there is no necessity to consider randomizing contracts.

most interesting case in which the parties would agree on implementing high effort in a first-best world, i.e. if effort were verifiable. Hence, it is assumed that $c \leq R\Delta p$ holds. This means that $p_H R - c \geq p_L R$, so the first-best effort choices are $e_1^{FB} = 1$ and $e_2^{FB}(0) = e_2^{FB}(1) = 1$. I say that "the first-best is achieved" if the effort levels are high in equilibrium.

3 Scenario I: Commitment

In this section it is assumed that the principal can offer a contract that includes an enforceable clause which prevents renegotiation. This is the assumption typically made in the economic literature on mechanism design. Even if this assumption is in contrast to existing contract law, its implications have to be studied in order to assess the welfare consequences of an institutional change that would make the enforcement of non-renegotiation clauses a practical possibility. The following proposition summarizes the main findings for scenario I.

Proposition 1 *Assume that contractual terms preventing renegotiation are enforced. The principal always implements low effort [$e = (0, 0, 0)$] if*

$$R \leq \frac{(1 + \Delta p)\, p_H}{(1 + \Delta p) p_H - p_L} \frac{c}{\Delta p}.$$

She always implements high effort [$e = (1, 1, 1)$] if

$$R \geq \frac{(1 - \Delta p)\, p_H}{(1 - \Delta p) p_H - p_L} \frac{c}{\Delta p}.$$

Otherwise, she implements high effort in the first stage, while she implements high effort in the second stage if and only if the first stage was a success [$e = (1, 0, 1)$].

Proof. See the appendix. ■

In order to understand the proposition intuitively, consider for a moment the one-shot version of the model and assume that the principal wants to induce high effort. She then wants to reward the agent for a success and punish him for a failure. Since negative wages are impossible due to the wealth constraint, the wage payment will be zero in case of a failure. The agent has an incentive to work hard if the bonus payment in case of a success satisfies the condition $p_H \cdot bonus - c \geq p_L \cdot bonus$, so that the principal will set $bonus = c/\Delta p$. The expected profit of the principal if she induces high effort in the one-shot model is thus given by $p_H (R - c/\Delta p)$.

Now consider the two-stage model. If the principal always induces high effort in the second stage, then the rent that the agent expects to get from the second stage is independent of the outcome of the first stage. If the principal wants to induce high effort in the first stage, she must hence also reward a first-stage success with a bonus $c/\Delta p$. As a result, the principal's expected profit in the two-stage model is simply $2p_H (R - c/\Delta p)$ if she implements $e = (1, 1, 1)$.

Next, suppose that the principal wants to always implement low effort, $e = (0, 0, 0)$. It then is obviously optimal for her to make no bonus payment, so that her expected profit is $2p_L R$.

Finally, the principal might want to implement high effort in the second stage if and only if the first stage was a success. In order to see this, note that then the agent can earn no rent in the second stage if the first stage was a failure. Yet, if the first stage was a success, he will earn the rent $p_H \cdot c/\Delta p - c = p_L c/\Delta p$ in the second stage. Now consider the first stage. The agent knows that he will get the second stage rent $p_L c/\Delta p$ if and only if the first stage is a success. Hence, the principal can reduce the bonus that she must offer the agent in order to induce high effort in the first stage. In fact, the agent will choose $e_1 = 1$ if $p_H \cdot (bonus + p_L c/\Delta p) - c \geq$

$p_L \cdot (bonus + p_L c/\Delta p)$, so that it is optimal for the principal to set $bonus = (1-p_L)c/\Delta p$. She pays this bonus if the first stage was a success, which happens with probability p_H. If then the second stage is also successful, she pays in addition the bonus $c/\Delta p$ for a second-stage success, so that the principal's expected total payment to the agent is $p_H\left[(1-p_L)c/\Delta p + p_H c/\Delta p\right]$. Hence, if the principal implements $e = (1,0,1)$, her expected profit is $p_H R + \left[p_H^2 + (1-p_H)p_L\right] R - p_H(1+\Delta p)c/\Delta p$.

Of course, the higher are the stakes R, the more attractive it is for the principal to induce high effort. The relevant cut-off levels of R that distinguish the three regimes $e = (0,0,0)$, $e = (1,0,1)$, and $e = (1,1,1)$ can easily be derived by a straightforward comparison of the principal's expected profits in the three cases.

4 Scenario II: Renegotiation

In this section it is assumed that contractual terms which rule out renegotiation are not enforced by the courts, which is in accordance with the current legal practice: "Those who make a contract, may unmake it."[11]

Specifically, it is assumed that after the outcome of the first stage has been realized, the principal and the agent can agree to modify their original contract; i.e, replace it by a new one. Recall that high effort is always first-best by assumption. Hence, whenever the original contract induces high effort in the second stage, there can be no scope for renegotiation, because at least one party must be worse off when a first-best decision is

[11] Opinion of Justice Cardozo in *Beatty v. Guggenheim Exploration Co.,* 122 N.E. 378, 387-88 (N.Y. 1919). Cf. also Restatement (Second) of Contract §311 cmt. a (1979): "The parties to a contract cannot by agreement preclude themselves from varying their duties to each other by subsequent agreement." See, however, Davis (2003) on legal possibilities to circumvent the non-enforcement of anti-modification clauses.

replaced by another decision.[12]

Suppose now that the principal would induce $e_2(0) = 0$ if commitment were possible. Is low second-stage effort still implementable if renegotiation cannot be prevented? Assume first that the original contract offered no payment after a first-stage failure. The principal's expected profit from the second stage after a first-stage failure then is $p_L R$ if she induces low effort, while it is $p_H(R - c/\Delta p)$ otherwise. Thus, at the beginning of the second stage it is in the principal's interest to induce high second-stage effort if $R \geq p_H c/(\Delta p)^2$, which would also make the agent better off.[13] In this case, $e_2(0) = 0$ is no longer implementable. Moreover, it is straightforward to show that the principal could not make $e_2(0) = 0$ implementable by offering in the original contract positive payments after a first-stage failure (see the appendix).

Observe now that

$$\frac{(1+\Delta p)\, p_H}{(1+\Delta p)p_H - p_L}\frac{c}{\Delta p} < \frac{p_H c}{(\Delta p)^2} < \frac{(1-\Delta p)\, p_H}{(1-\Delta p)p_H - p_L}\frac{c}{\Delta p}.$$

Hence, if the principal wants to implement $e = (0, 0, 0)$ under commitment according to Proposition 1, she will not change her mind once the first stage is completed, because for these parameter constellations low second-stage effort remains implementable. Yet, if $e = (1, 0, 1)$ would be induced under commitment, the impossibility to prevent renegotiation may become relevant. To see this, assume that the first stage was a failure, so that according to the original contract low effort should be implemented. If however $R \geq p_H c/(\Delta p)^2$, then $e_2(0) = 0$ is no longer implementable, because the principal will

[12] In our complete contracting framework, the principal cannot be better off now than in scenario I. Hence, it will clearly be optimal for the principal to offer the same contract as in scenario I if this contract does not lead to renegotiation.

[13] Of course, if $R < p_H c/(\Delta p)^2$, the agent would still like the principal to implement high effort, but the principal is not willing to offer the agent the rent that is necessary to induce high effort.

now want to induce high effort in the second stage. Suppose that the principal can offer the contract modification. The agent will accept the new contract, because he then earns the rent $p_L c/\Delta p$, while the agent would get no rent under the original contract. Yet, if the principal anticipates that there will be renegotiation leading to $e_2(0) = 1$, it is optimal for her to offer at the outset the contract that implements $e = (1, 1, 1)$ derived in scenario I.

Note that following the principal-agent literature, it has been assumed that the principal offers the original contract to the agent. One might argue that bargaining strengths should be more evenly distributed in the renegotiation phase. It is true that at the outset there may be many potential agents, which justifies the usual assumption that the principal can make a take-it-or-leave-it offer. Yet, once the relationship has started, the principal can by assumption no longer switch to a different agent (the parties are "locked-in," which is also known as Williamson's (1985) "fundamental transformation"), so it may be reasonable to suppose that now the agent is in an improved bargaining position. Therefore, renegotiation is modelled here by the generalized Nash bargaining solution, where the principal's bargaining power is given by a parameter $\alpha \in [0, 1]$.[14] It should be noted that the findings summarized in the following proposition do not depend on α.[15]

Proposition 2 *Assume that non-renegotiation clauses are not enforced. The principal*

[14] In the present framework, one simple interpretation is that the principal can offer the new contract with probability α, while the agent can make the offer with probability $1-\alpha$. This bargaining protocol is used by Hart and Moore (1999).

[15] If the principal anticipates that a contract inducing low second-stage effort will be renegotiated, she can offer at the outset a contract inducing high second-stage effort, so that it is inconsequential which fraction of the renegotiation surplus would go to the agent.

always implements low effort [$e = (0, 0, 0)$] if

$$R \leq \frac{(1 + \Delta p)\, p_H}{(1 + \Delta p) p_H - p_L} \frac{c}{\Delta p}.$$

She always implements high effort [$e = (1, 1, 1)$] if

$$R \geq \frac{p_H c}{(\Delta p)^2}.$$

Otherwise, she implements high effort in the first stage, while she implements high effort in the second stage if and only if the first stage was a success [$e = (1, 0, 1)$].

Proof. See the appendix. ■

5 Should non-renegotiation terms always be enforced?

The consequences of institutional changes that would make contractual non-renegotiation clauses enforceable can now be assessed by a straightforward comparison of Proposition 1 and Proposition 2. In particular, it turns out that high effort will more often be implemented in scenario II, which supports the current legal framework.

Proposition 3 *There are situations in which the first-best is achieved if the courts do not enforce contractual terms preventing renegotiation, while the first-best would not be achieved if such terms were made enforceable. Specifically, this is the case if*

$$\frac{p_H c}{(\Delta p)^2} < R < \frac{(1 - \Delta p)\, p_H}{(1 - \Delta p) p_H - p_L} \frac{c}{\Delta p}.$$

Otherwise, the same effort profiles are implemented in both scenarios.

Proof. This follows immediately from Proposition 1 and Proposition 2. ■

In other words, if the interaction between the contractual parties that might lead to renegotiation merely consists of a repetition of the simplest possible moral hazard

model, lawmakers should not pay attention to the advice of economists who want to permit parties to enter into nonmodifiable contracts. Even if institutional changes enabling the enforcement of contractual non-renegotiation clauses were a practicable possibility, they would merely make the principal better off at the costs of the agent, while the first-best benchmark solution would be achieved less often.

An extended model. The fact that such a strong and unambiguous conclusion can be drawn from the analysis of the basic model does not rule out the possibility that a reorientation of the legal perspective on contract modification might be socially desirable under different circumstances. It is indeed not difficult to construct variants of the model in which the enforcement of clauses that prevent renegotiation may be welfare enhancing. For instance, assume that at date 0 the principal can decide whether to enter the relationship with the agent or alternatively pursue another project by herself. The alternative project yields a total benefit B to the principal. It is possible to construct examples in which the principal prefers to pursue the alternative project if renegotiation cannot be ruled out, while she would implement $e = (1, 0, 1)$ in the relationship with the agent if renegotiation could be prevented.[16] The fact that then the principal's expected profit from implementing $e = (1, 0, 1)$ under commitment is larger than B implies that the alternative project should not be pursued from a social perspective.[17] In this case, changing the legal practice to enable commitment would be beneficial.

Proposition 4 *Assume that instead of entering the relationship with the agent, the principal could alternatively pursue another project that yields benefit B. It is then*

[16] In order to see this, recall that there are situations in which the principal would implement $e = (1, 0, 1)$ under commitment, while she can only implement $e = (1, 1, 1)$ given renegotiation, so that her expected profit in the latter case must be smaller.

[17] Note that the agent gets a rent in the relationship, while he would only get his reservation utility if the principal chose the alternative project.

conceivable that the principal will pursue the alternative project if renegotiation cannot be prevented, while she would not do so if commitment were made possible. Specifically, this happens if

$$\begin{aligned} & \max\left\{\frac{p_H c(1+\Delta p)+B\Delta p}{(1+p_H)(\Delta p)^2+2p_L\Delta p}, \frac{p_H c}{(\Delta p)^2}\right\} \\ < \quad & R < \min\left\{\frac{2p_H c+B\Delta p}{2p_H\Delta p}, \frac{(1-\Delta p)\,p_H}{(1-\Delta p)p_H-p_L}\frac{c}{\Delta p}\right\}. \end{aligned}$$

In this case, it would be socially desirable to enforce contractual non-renegotiation terms.

Proof. See the appendix. ■

Taken together, Propositions 3 and 4 show that it depends upon the specific situation under consideration whether or not it is socially desirable to let courts enforce contractual terms preventing renegotiation. In any case, it is far from being obvious that the recommendation to change the legal practice with regard to the enforcement of terms constraining contract modifications would always be a good advice.[18]

6 Conclusion

Is renegotiation good or bad? There is no general answer to this question. A simple, incomplete contract that can be renegotiated may sometimes be a substitute for a complex, complete contract.[19] However, in such cases the parties apparently have no reason

[18] If legal rules must be general and cannot rely on evaluating welfare on a case-by-case basis, the lawmaker may conclude that the current rule (not to enforce anti-modification clauses) fares better on average, which may help to provide one missing link in the foundations of incomplete contracts literature. [The 'foundations' literature in the spirit of Hart and Moore (1999) and Segal and Whinston (2001) crucially relies on the assumption that renegotiation cannot be prevented. Maskin and Tirole (1999) criticize that this assumption has not been explicitly explained.]

[19] E.g., in the literature on the hold-up problem, Chung (1991), Aghion, Dewatripont and Rey (1994), Nöldeke and Schmidt (1995), Edlin and Reichelstein (1996), Edlin (1996), De Fraja (1999),

to explicitly rule out renegotiation. The recent contract-theoretic literature seems to suggest that if parties deliberately want to enter into a nonmodifiable contract, then contractual terms that prevent renegotiation should be enforced, which is in contrast to the current legal practice.[20]

In this paper it has been shown that institutional changes that would permit parties to enter into nonmodifiable contracts might not be socially desirable, even if there is no precontractual private information. A straightforward two-period extension of the simplest moral hazard model that is well known from textbooks turned out to be sufficient to make this point. The present paper hence supports the view of Hart and Moore (1999), who are sceptical about the merits of the system-wide institutional change that would enable commitment as envisioned by mechanism design theorists. While these authors mention the administrative costs associated with such a change and the impact of bounded rationality, the present contribution shows that a new contract law which would permit parties to enter into nonmodifiable contracts might also have negative incentive effects, even if parties are rational.

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and Schmitz (2002) show that simple contracts plus renegotiation can be as effective as the complete contracts analyzed by Rogerson (1992) and Hermalin and Katz (1993). For a related point in a moral hazard model with a risk averse agent and observable actions, see Hermalin and Katz (1991).

[20]For instance, see Maskin and Tirole (1999) and cf. Hart and Moore (1988), Maskin and Moore (1999), Che and Hausch (1999), Edlin and Hermalin (2000), and Segal and Whinston (2002) in the context of the hold-up literature, or see Fudenberg and Tirole (1990) in the context of a traditional moral hazard model with a risk-averse agent. In the latter context, Ma (1994) and Matthews (1995) show that the conclusions can be sensitive to who makes the proposal in the renegotiation stage.

Appendix

Proof of Proposition 1.

The principal offers a contract $w = (w_{00}, w_{01}, w_{10}, w_{11})$ inducing the effort profile $e = (e_1, e_2(0), e_2(1))$ to the agent in order to maximize her expected profit

$$\begin{aligned}
&(e_1 p_H + (1-e_1)p_L)\left[R + (e_2(1)p_H + (1-e_2(1))p_L)\,(R - w_{11})\right.\\
&\left. - (1 - (e_2(1)p_H + (1-e_2(1))p_L))\,w_{10}\right]\\
&+ (1 - (e_1 p_H + (1-e_1)p_L))\left[(e_2(0)p_H + (1-e_2(0))p_L)\,(R - w_{01})\right.\\
&\left. - (1 - (e_2(0)p_H + (1-e_2(0))p_L))\,w_{00}\right]
\end{aligned}$$

subject to the agent's incentive compatibility constraints (which ensure that it is in the agent's interest to choose the effort profile e that the principal wants to implement) and the wealth constraint $w \geq 0$. The agent's individual rationality constraint which ensures that the agent will participate (i.e., accept the principal's contract offer) is always satisfied due to $w \geq 0$.

The incentive compatibility constraints are as follows. When the first stage was a failure, the agent is willing to work hard in the second stage $[e_2(0) = 1]$ if $p_H w_{01} + (1 - p_H)w_{00} - c \geq p_L w_{01} + (1 - p_L)w_{00}$, which can be simplified to

$$w_{01} - w_{00} \geq \frac{c}{\Delta p}.$$

Similarly, when the first stage was a success, the agent works hard $[e_2(1) = 1]$ if

$$w_{11} - w_{10} \geq \frac{c}{\Delta p}.$$

The agent works hard in the first stage $[e_1 = 1]$ if

$$\begin{aligned}
&e_2(1)\,(p_H w_{11} + (1-p_H)w_{10} - c) + (1 - e_2(1))\,(p_L w_{11} + (1-p_L)w_{10})\\
&-e_2(0)\,(p_H w_{01} + (1-p_H)w_{00} - c) - (1 - e_2(0))\,(p_L w_{01} + (1-p_L)w_{00}) \geq \frac{c}{\Delta p}.
\end{aligned}$$

Assume first that the principal wants to implement $e = (1, 1, 1)$. It is straightforward to check that in this case the agent will work hard in the first stage if

$$p_H (w_{11} - w_{01}) + (1 - p_H) (w_{10} - w_{00}) \geq \frac{c}{\Delta p}.$$

Hence, if the principal wants to ensure that the agent always works hard, she will set $w_{00} = 0$, $w_{01} = c/\Delta p, w_{10} = c/\Delta p - \omega$, and $w_{11} = 2c/\Delta p + (1 - p_H)\omega/p_H$, where $\omega \in [0, c/\Delta p]$. Her expected profit then is given by $2p_H (R - c/\Delta p)$. Note that this is simply twice the profit the principal would expect when she induced the agent to work hard if there were only one stage.

Next, assume that the principal wants to implement $e = (0, 0, 0)$. It is obvious to see that she will set $w = 0$ and her expected profit is $2p_L R$.

Now assume that the principal wants to implement $e = (1, 0, 1)$. The agent's first-stage incentive compatibility constraint then reads

$$p_H w_{11} + (1 - p_H) w_{10} - p_L w_{01} - (1 - p_L) w_{00} \geq \frac{(1 + \Delta p)c}{\Delta p}.$$

Hence, $w_{00} = w_{01} = 0$, $w_{10} = (1-p_L)c/\Delta p - \omega$, and $w_{11} = (2-p_L)c/\Delta p + (1-p_H)\omega/p_H$, where $\omega \in [0, (1-p_L)c/\Delta p]$. The expected profit then is $[p_H(1 + p_H) + (1 - p_H)p_L] R - (1 + \Delta p)p_H c/\Delta p$.

It is straightforward to check with similar calculations that the principal will never find it optimal to implement $e = (1, 0, 0)$, $e = (0, 1, 1)$, $e = (0, 1, 0)$, $e = (0, 0, 1)$, or $e = (1, 1, 0)$. Specifically, if the principal implements $e = (1, 0, 0)$ or $e = (0, 1, 1)$, her expected profit is $p_H (R - c/\Delta p) + p_L R$. If she implements $e = (0, 1, 0)$, her expected profit is $(1 - p_L)p_H (R - c/\Delta p) + (1 + p_L)p_L R$; if she implements $e = (0, 0, 1)$, it is $p_L p_H (R - c/\Delta p) + (2 - p_L)p_L R$; if she implements $e = (1, 1, 0)$, it is $(2 - \Delta p)p_H(R - c/\Delta p)$. Hence, in each case either $e = (1, 1, 1)$ or $e = (0, 0, 0)$ would lead to larger profits.

Finally, observe that the principal's expected profit from implementing $e = (1, 0, 1)$ is higher than her expected profit from implementing $e = (0, 0, 0)$ if the condition $[p_H(1 + p_H) + (1 - p_H)p_L] R - (1 + \Delta p)p_H c/\Delta p > 2p_L R$ is satisfied, which can be simplified to

$$R > \frac{(1 + \Delta p)\, p_H}{(1 + \Delta p)p_H - p_L} \frac{c}{\Delta p}.$$

Her expected profit from implementation of $e = (1, 0, 1)$ is higher than her expected profit from implementing $e = (1, 1, 1)$ if $[p_H(1 + p_H) + (1 - p_H)p_L] R - (1+\Delta p)p_H c/\Delta p > 2p_H (R - c/\Delta p)$, which is equivalent to

$$R < \frac{(1 - \Delta p)\, p_H}{(1 - \Delta p)p_H - p_L} \frac{c}{\Delta p}.$$

This completes the proof of Proposition 1. ■

Proof of Proposition 2.

After the outcome of the first stage has been realized, the parties can agree on a new contract, denoted by (w'_{00}, w'_{01}) if $x_1 = 0$ and by (w'_{10}, w'_{11}) if $x_1 = 1$. Since high effort is first-best, there can only be scope for renegotiation if the original contract induces low effort in the second stage.[21] Suppose that the original contract implements $e_2(0) = 0$, so that $w_{01} - w_{00} < \frac{c}{\Delta p}$. Let $w_0 = p_L w_{01} + (1 - p_L)w_{00}$. In order to induce the agent to exert high effort, the new contract must satisfy the incentive constraint $w'_{01} - w'_{00} \geq c/\Delta p$. Without loss of generality, let $w'_{00} = 0$, so that if the parties agree on a new contract, the

[21] Specifically, suppose the original contract induces $e = (1, 0, 1)$ and the first stage is a success. The principal might consider to offer a new contract (w'_{10}, w'_{11}) inducing $e_2(1) = 0$. Without loss of generality, suppose $w'_{10} = w'_{11}$. Under the original contract, the agent's expected payoff following $x_1 = 1$ is $p_H w_{11} + (1 - p_H)w_{10} - c$. Hence, the principal must set $w'_{10} = p_H w_{11} + (1 - p_H)w_{10} - c$ in order to persuade the agent to sign the new contract. The principal would offer a new contract if $p_L R - w'_{10} > p_H(R - w_{11}) - (1 - p_H)w_{10}$, or $c > R\Delta p$, which means that low effort had to be first-best, in contrast to what has been assumed.

principal's expected profit is $p_H(R - w'_{01})$ and the agent's expected payoff is $p_H w'_{01} - c$. If renegotiation fails, i.e. if the original contract that induces low effort remains in place, then the principal's expected profit is $p_L R - w_0$, while the agent's expected payoff is w_0.

According to the generalized Nash bargaining solution,[22] if the parties agree on a new contract, the wage w'_{01} will maximize

$$(p_H(R - w'_{01}) - p_L R + w_0)^{\alpha}(p_H w'_{01} - c - w_0)^{1-\alpha},$$

subject to $p_H(R - w'_{01}) \geq p_L R - w_0$, $p_H w'_{01} - c \geq w_0$, and $w'_{01} \geq c/\Delta p$, where $\alpha \in [0, 1]$ is the principal's bargaining power. It is straightforward to see that renegotiation will succeed whenever $R \geq [p_H \max\{c/\Delta p, (c + w_0)/p_H\} - w_0]/\Delta p$. Note that it can never be in the principal's interest to offer $w_0 > 0$ in the original contract, since this could only make $e_2(0) = 0$ more difficult to implement and worsen the principal's bargaining position. Hence, consider $w_0 = w_{01} = w_{00} = 0$. If $R \geq p_H c/(\Delta p)^2$, renegotiation would take place, so that $w'_{01} = \max\{c/\Delta p, [(1 - \alpha)\Delta p R + \alpha c]/p_H\}$ and the new contract would induce high effort.[23]

Of course, renegotiation would be anticipated by the agent, so the principal could no longer reduce the agent's bonus that is required to induce $e_1 = 1$ by a credible threat to implement low effort following a first-stage failure. Hence, if $R \geq p_H c/(\Delta p)^2$ it is optimal for the principal to offer at the outset a contract inducing $e = (1, 1, 1)$ as characterized in the proof of Proposition 1.

[22] For a recent textbook treatment of the Nash bargaining solution, see Muthoo (1999).

[23] It can be checked that this bargaining solution would be obtained by the simple non-cooperative bargaining game in which the principal makes a take-it-or-leave-it offer with probability α, and the agent with probability $1 - \alpha$.

Finally, recall that under commitment the principal would only induce $e_2(1) = 0$ if

$$R \leq \frac{(1+\Delta p)\, p_H}{(1+\Delta p)p_H - p_L} \frac{c}{\Delta p} < \frac{p_H c}{(\Delta p)^2}.$$

It is hence straightforward to see that renegotiation following $x_1 = 1$ does not have to be considered. ■

Proof of Proposition 4.

Suppose that

$$2p_H \left(R - \frac{c}{\Delta p} \right) < B < \left[p_H(1+p_H) + (1-p_H)p_L \right] R - \frac{1+\Delta p}{\Delta p} p_H c$$

holds. The first inequality says that the principal's expected profit in the relationship with the agent given $e = (1,1,1)$ is smaller than her profit from pursuing the alternative project. The second inequality means that the principal will not pursue the alternative project if she can implement $e = (1,0,1)$ in the relationship with the agent. Note that the latter inequality immediately implies that from a social perspective implementing $e = (1,0,1)$ is clearly better than pursuing the alternative project. Note also that the two inequalities can be rewritten as

$$\frac{p_H c(1+\Delta p) + B\Delta p}{(1+p_H)(\Delta p)^2 + 2p_L \Delta p} < R < \frac{2p_H c + B\Delta p}{2p_H \Delta p}.$$

Now recall that the principal's expected profit in the relationship with the agent only differs between the two scenarios I and II if

$$\frac{p_H c}{(\Delta p)^2} < R < \frac{(1-\Delta p)\, p_H}{(1-\Delta p)p_H - p_L} \frac{c}{\Delta p}.$$

In this case, the principal would implement $e = (1,0,1)$ if commitment were made possible, while she would pursue the alternative project [which is now more profitable for her than implementing $e = (1,1,1)$ in the relationship with the agent] if renegotiation could not be prevented.

It remains to show that it is possible to satisfy all these inequalities simultaneously. In order to prove this, it is sufficient to give an example. It is easy to check that all conditions are satisfied if e.g. $p_H = .8$, $p_L = .4$, $c = 1$, and $R = B = 6$. ■

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