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PROCUREMENT AND RENEGOTIATION

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ABSTRACT

Parties bound by an incomplete contract have an incentive to renegotiate after acquiring new information. The issue of the parties' investment in the relationship before renegotiation is analyzed in a simple two-period procurement model. The firm invests in the first period. It then learns its production cost and the sponsor learns its value for the project. Williamson's underinvestment presumption is shown to hold under very general assumptions about bargaining and about the ex-post asymmetry of information, as long as the firm's investment is not observable by the sponsor.
The introduction of a cancellation fee may well lead to even less investment contrary to what is sometimes argued. The role of ex-ante price fixing as an alternative way to reintroduce some form of commitment and the problem of cost overruns are discussed. Lastly, it is shown that if investment is observable by the sponsor and thus may become a joint decision variable, the two parties may choose to under- or overinvest.

1. Introduction

Procurement is widely used by government agencies and private firms to perform their research, development and production projects. To some extent procurement can be considered the rule, since even in-house projects involve a decentralization of responsability to a research or a production department. The relationship between the buyer and the seller (the sponsor and the firm, say) is in general partly governed by a contract. But contracts are often incomplete and leave room for ex-post renegotiation between the parties. The purpose of this paper is to study the impact of renegotiation under a variety of assumptions about investment observability, ex-post observability and bargaining.

Section 2 presents a highly stylized two-period model. In the first period the firm invests in cost reduction. At the beginning of the second period the firm learns the (extra) cost it will incur if the project goes through. The sponsor learns its value for the project. Both data are private information. The two parties then bargain (noncooperatively) over whether to trade and over the price.

Section 3 gives two interpretations of this model. The straightforward one assumes that the parties do not "meet" before the firm's investment and the accrual of new information. In particular the firm invests before contracting. In the more interesting, but looser, interpretation, the two parties meet at the beginning of the first period, but are unable to sign complete contracts. That is, they are unable to commit themselves to a second-period mechanism of information exchange and decision making. Section

3 discusses this assumption, as well as the issue of the observability of the firm's investment.

A puzzling and unsolved issue in bargaining theory is the choice of the bargaining process. Section 4, which assumes that the firm's investment is not observed by the sponsor, avoids any commitment to a particular bargaining scheme between the two parties. It shows that, under a simple condition that is satisfied by a vast majority of bargaining schemes, the firm invests less than it would under symmetric information and complete contract ("first best" level). This formalizes Williamson's idea that "opportunism" leads to underinvestment in the relationship.

Section 5 assumes that the investment can be observed by the two parties. The latter meet in the first period and jointly decide on the firm's investment level (and on the investment sharing rule). To remain consistent with our no-long-run-commitment assumption, we assume that the two parties can specify only the first-period investment; i.e., they cannot constrain the future negotiation (see section 3 for situations that this short-run-commitment assumption might represent). It is shown that the mutually agreed upon investment may be lower than its level under non-observability, higher than the first best level, or intermediate between the two values. A sufficient but strong condition on bargaining is given for the investment under observability to exceed that under non-observability.

Sections 6 and 7 also assume that a contract is signed in the first period; and that this contract is incomplete and therefore renegotiation occurs in the second period. However the parties, although they cannot commit themselves not to renegotiate, can constrain bargaining somewhat, for instance, by affecting the status quo point. A third party (court) is introduced, who is able to observe whether trade occurs and possibly at which price. But this third party is incompetent to assess who is responsible for the breach, if any. This assumption is closely related to the motivation behind incomplete contracts. Section 6 supposes that the two parties can specify that the sponsor pay a cancellation fee if no trade occurs in the second period[1]. Cancellation fees are of considerable practical interest as they have long been advocated by the U.S. Department of Defense for military procurement[2]. It is shown that they may well decrease the firm's investment in the relationship, contrary to what is sometimes argued.

The possibility for a third party to observe monetary transfers and trade also allows ex-ante price fixing. If the two parties can credibly commit themselves to a given price and choose to do so, the issue is the optimal allocation of decision rights to use decentralized information. Such rigid contracts (designed to save on "transaction costs") however are not in general ex-post efficient. If the parties cannot (or do not) want to commit themselves not to renegotiate, the issue becomes the meaning of the initial price estimate, and its effect on specific investment. These questions are addressed in section 7, which also discusses the concomitant and important notion of cost overruns.

2. The model.

The basic model involves two parties: the buyer (sponsor) and the seller (firm). There are two periods: t=1,2. In the second period the two

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[1] Cancellation fees are very similar to Shavell [1980,84]'s damage payments and to Williamson [1983]'s hostages.

[2] In fact, earlier restrictions on fees and more generally on Multi-Year Procurement have been removed by the 1982 Defense Authorization Act.

parties may trade a good manufactured by the firm. At time 1, the firm invests $e_1 \geq 0$ in "cost reduction". At the beginning of time 2, it learns the production cost it will incur in case of trade, $c_2 = C_2(e_1, \theta)$, where θ is a random variable and C_2 is differentiable and decreasing in e_1. For simplicity, we will assume that the support of the cost distribution is independent of investment; and that the chosen level of investment is always strictly positive[3]. Also at the beginning of time 2, the sponsor learns its project $v_2 = V_2(\eta)$, where η is a random variable. We assume that θ and η are independent and that their distributions, although not their realizations, as well as all other data are common knowledge. We thus assume that information is symmetric at date 1[4]. For notational simplicity we will from now on suppress the random variables and simply write: $c_2 = \tilde{C}_2(e_1)$ and $v_2 = \tilde{V}_2$. Unless otherwise stated, $\tilde{C}_2$ and $\tilde{V}_2$ are also assumed to have continuous distributions on their respective supports.

As suggested by the above presentation, only the firm knows its production cost; and only the sponsor knows its value. The sponsor may or may not observe the investment made by the firm in the first period. After

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[3]This could be derived by assuming that the marginal cost reduction is infinite at zero: $\frac{\partial C_2}{\partial e_1}(0, \theta) = -\infty$ for all θ.

[4]This is not to say that adverse selection problems in procurement are not important; they certainly are (see, e.g., Scherer [1964, p.227]). This assumption is not crucial. It simplifies the exposition in the case in which the two parties sign a short term contract at date 1. Bargaining over the first contract then occurs under "complete information".

learning respectively c_2 and v_2, the firm and the sponsor bargain non cooperatively over whether to produce the good and over its price. As there is some leeway in specifying the way the parties bargain, we will either rely on general properties of bargaining equilibria or study more specific bargaining schemes to illustrate the main features.

Lastly the two parties have identical discount factor γ between the two periods, and, unless otherwise stated, are both risk neutral.

Before discussing the model, let us solve for the symmetric-information-complete-contract-outcome. In the second period the two parties trade if and only if there are gains from trade: $v_2 \geq c_2$. The first-best level of investment, e_1^*, is then chosen to maximize

$$\Pi(e_1) = -e_1 + \gamma \int_{\{\tilde{V}_2 \geq \tilde{C}_2(e_1)\}} (\tilde{V}_2 - \tilde{C}_2(e_1)).$$

We make an assumption ensuring that this maximization problem has a unique solution:

A1) $\Pi(e_1)$ is strictly concave.

The first-best investment is then uniquely defined by:

$$(1) \qquad -1 \; -\gamma \int_{\{\tilde{V}_2 \geq \tilde{C}_2(e_1)\}} \frac{\partial \tilde{C}_2}{\partial e_1} = 0.$$

In other words, the marginal cost of investment is equal to the discounted marginal cost reduction conditional on trade taking place.

3. Discussion of the model.

i) Interpretations: A simple way to comprehend the model is to imagine that the firm invests before "meeting" with the "sponsor". This does not mean that the firm is unaware of the existence of a potential trading partner; otherwise it would have no incentive to make any specific investment. It may simply not have yet selected its trading partner. Or it may know in advance the identity of the sponsor, but it is required to supply a well-defined project in order for the latter to be willing to consider signing a production contract.

The second, and maybe more appealing, interpretation of the model supposes that the sponsor and the firm do meet and sign a contract at date 1, before the firm invests. This contract, however, does not specify long-run (date 2) events. In other words the two parties are unable to lock themselves into a long-run contract specifying information exchange and decisions in date 2.

ii) Commitment. The absence of commitment ought to be discussed; for it underlies explicitly the second interpretation, and implicitly the first one.

Military procurement is a good example for this, since there is considerable evidence on the topic and renegotiation is an important issue in such contracts. The case study literature has discussed two main reasons for the absence of real commitment: transaction costs and the possibility of breach. Before mentioning the two arguments, we ought to warn the reader that the analysis here is very informal, since it refers to considerations outside the scope of the model. We hope that future research will develop better foundations for the incompleteness of contracts (thus allowing a more thorough analysis of renegotiation.)

The traditional explanation of incomplete contracts relies on the existence of transaction costs. First some contingencies may not be foreseeable. Second it may be expensive and time consuming to write the (high number of) foreseeable ones in a contract. Third, some contingencies may be private information (as is the case here). A complete contract must then specify an "incentive-compatible" mechanism of information transmission, which makes it particularly expensive. All this may make incomplete contracts and renegotiation an attractive alternative. This is particularly true for military procurement for two reasons. First a number of contracts are signed in a rush to get the research going (see Peck-Scherer [1962, p. 417]). Second, for risky R&D projects, design changes are the rule rather than the exception. There ex-ante exists a large number of such changes (assuming they can be foreseen). Furthermore they are contingent on technical information, that the courts usually do not possess (which is natural since the parties themselves did not possess the information at the start). Clearly any design change not specified in the contract partly invalidates this contract[5]. It is therefore not surprising that the necessity or desirability of design changes often trigger a renegotiation of the initial contract.

The transaction costs explanation emphasizes the incompleteness of contracts and the need for renegotiation to realize gains from trade not specified by the initial contract. The breach of contract argument rests on the impossibility of enforcing the initial contract. The firm may go bankrupt if at some point of time the prospects associated with the project become bleak. Similarly the sponsor may go bankrupt if it is a private firm, or cancel the project if it is a government agency (Congress). These features put ("individual rationality") constraints on contracts that can be enforced. They weaken the case for complete contracts by lowering their efficiency. The breach of contract argument,

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[5]The initial contract may still serve as a status-quo point in the renegotiation over design changes. See section 7.

rather than being an alternative to the transaction cost argument, reinforces it by strengthening the case for renegotiation (which, by definition, satisfies the second-period voluntary participation constraints).

iii) Information. The assumption that the sponsor, but not the firm, observes the (expected) value of the project is natural. The sponsor usually is or works for the final user. The firm in general lacks information about the value. One reason is that the value can be subjective. Also even if it somehow is objective, the sponsor is usually endowed with superior information. For example the Department of Defense may know better than a contracting firm about the efficiency of a weapons system in front of other strategic forces or about the state of the latter. Furthermore it may have better information about the possibility of substitution by systems developed by other firms.

Let us now consider the assumption that the production cost c_2 is not observed by the sponsor (even in the case of trade). This assumption is made in most of the literature on procurement under asymmetric information. The reasonableness of this assumption depends on the particular context. Aggregate cost data for a firm are often easy to obtain. However it sometimes is not very informative. First, the project under consideration may be only one of the firm's several projects, where the latter refer to other sponsors or customers. This creates serious problems since the firm is then able to shift costs both at an accounting and at real levels. Costs associated with another activity of the firm may be written up in the project. The firm can also shift good engineers, or more generally priorities, from one project to the other. Lastly, it may use inexperienced in-house groups instead of a subcontractor in order to diversify into a new field. To prevent these shifts the sponsor must audit carefully. But auditing is often poor; even a highly competent accountant is unable to make judgments requiring a "sound understanding of the technology involved", i.e., to access the true costs of inputs (Peck-Scherer [1962], pp. 417,514). Second the firm's cost may reflect its (unobservable) opportunity cost[6]. Third, even if the final cost of the project is observable, moral hazard and uncertainty may garble the link between the firm's information when renegotiating (c_2) and the final cost of the project (for a theory of procurement under adverse selection, moral hazard and final cost observability, see Laffont-Tirole [1984]). So we conclude that in a number of interesting procurement situations, the production cost may be assumed to be (at least partially) unobservable by the sponsor.

As for the investment cost e_1, we consider the two cases of observability and unobservability by the sponsor. The reasons why the investment may not be observable are identical to those for the production cost. In some cases, however, the investment cost may be observed by the sponsor; this is the case for instance if the project requires a choice among well-defined and commonly agreed upon equipments. If investment is observable and if the two parties meet in period 1, they have a mutual interest in signing a contract specifying the level of investment (and its financing). We will however assume that, because of design changes or other reasons mentioned earlier, they can only specify the (short-run) investment decision in the contract.

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[6]This remark is particularly relevant for military procurement: "undercapacity operation is quite common in the rapidly changing defense industry". (Scherer [1964], p. 183).

4. Unobservable investment

As mentioned in the introduction there exist many extensive forms that circumstances can impose on the two parties in their second-period bargaining. Fortunately, when investment is unobservable, the analysis requires only a weak assumption on the bargaining process, which we leave unspecified at the current stage.

Let us introduce some notation. For a given bargaining scheme and equilibrium of the corresponding bargaining game, let $\Phi_2(c_2,\bar{e}_1)$ denote the expected payoff of the firm in the second period, when the firm has production cost c_2 and the sponsor believes that the firm has invested $\bar{e}_1$ in the first period (under unobservability, the real investment e_1 may differ from the expected investment $\bar{e}_1$. But they are equal in equilibrium. If the sponsor believes the firm has randomized among investment levels, $\bar{e}_1$ denotes this mixed strategy). The level of investment anticipated by the sponsor matters since it determines the sponsor's beliefs about the firm's production cost, and therefore affects its bargaining behavior. Note that the sunk investment cost e_1 does not enter Φ_2, while the production cost c_2 does. Note also that Φ_2 is an expectation over the sponsor's value and depends on the bargaining process. To clarify this notion, let us give two simple examples:

Example 1: In the second period the firm makes a take-it-or-leave-it offer p. The sponsor can either pay p and trade, or reject p. So the sponsor accepts if and only if $p<v_2$. In this example the sponsor's behavior is independent of its beliefs about the firm's investment. So both the price charged by the firm, $p_f(c_2,\bar{e}_1)$, and the latter's expected second period

profit, $\Phi_2(c_2,\bar{e}_1)$, depend only on c_2. We have:

$$\Phi_2(c_2,\bar{e}_1)=\max_p\{(p-c_2)\Pr(v_2\geq p)\}=(p_f(c_2,\bar{e}_1)-c_2)\Pr(v_2\geq p_f(c_2,\bar{e}_1))$$

where "Pr" stands for "Probability that".

Notice that the price charged by the firm exceeds its production cost.

Example 2: Imagine that the sponsor makes a take-it-or-leave-it offer p. The firm accepts this offer if and only if $c_2\leq p$. The equilibrium offer $p_s(v_2,\bar{e}_1)$ maximizes:

$$\max_p\{(v_2-p)\Pr(c_2\leq p \mid \bar{e}_1)\}.$$

Note that the sponsor makes an offer that does not exceed its value and that:,

$$\Phi_2(c_2,\bar{e}_1)=\int_{\{v_2 \mid p_s(v_2,\bar{e}_1)\geq c_2\}}(p_s(v_2,\bar{e}_1)-c_2).$$

Let us now come back to general bargaining processes and make the following assumption:

A2) For almost all c_2, $\Phi_2(c_2,\bar{e}_1)$ is differentiable in c_2 and

$$\left|\frac{\partial\Phi}{\partial c_2}\right|\leq\Pr(v_2\geq c_2).$$

Assumption A2) says that the derivative of the firm's second period expected profit with respect to cost is in absolute value bounded above by the probability of trade in the complete-contract-symmetric-information case.

Assumption A2) is clearly satisfied in the two examples above. When the firm makes a take-it-or-leave-it offer, the envelope theorem implies that $\left|\frac{\partial\Phi_2}{\partial c_2}\right|=\Pr(v_2\geq p_f(c_2,\bar{e}_1))$. But $p_f(c_2,\bar{e}_1)\geq c_2$. So A2) is satisfied. Similarly when the sponsor makes a take-it-or-leave-it offer,

$\left|\frac{\partial\Phi_2}{\partial c_2}\right|=\Pr(p_s(v_2,\bar{e}_1)>c_2)$. As $p_s(v_2,\bar{e}_1)<v_2$, A2) follows.

A2) turns out to be a very general property associated with (perfect Bayesian) equilibria of most common bargaining games. It is satisfied for:

- most bargaining processes consisting of a sequence of offers and counter-offers. Examples include the firm's or the sponsor's making a take-it-or-leave-it offer, as well as the bargaining schemes considered in Cramton [1983,1984], Fudenberg-Tirole [1983], Fudenberg-Levine-Tirole [1984], Grossman-Perry [1984], Rubinstein [1983] and Sobel-Takahashi [1983].
- the Chatterjee-Samuelson [1983] simultaneous offer scheme, that implements (in the uniform case) the optimal mechanism with individual rationality constraints described in Myerson-Satterthwaite [1983].

In these games A2) comes from the conjunction of two properties:

1) Incentive compatibility: The derivative of Φ_2 with respect to c_2 must be bounded (in absolute value) by the probability that the firm trades when it has cost c_2. To explain why it must be so, consider the firm when it has cost (c_2+dc_2). It can always duplicate the equilibrium bargaining strategy it would adopt if it had cost c_2. Doing so will give it the same expected revenue. Therefore the difference in expected payoffs of the two types is bounded above by the probability that the firm trades when it has cost c_2. The difference may be smaller if bargaining is sequential and there is discounting because production costs may be delayed. It is equal to the probability of trade in examples 1 and 2, in which bargaining is instantaneous.

2) Undertrade: In most bargaining situations the probability that the firm

trades when it has cost c_2 is reduced by "opportunism" relative to its first best level.[7,8]

Assumption A2) is also satisfied in the literature on regulation under asymmetric information. There in the terminology of this paper, the sponsor makes a take-it-or-leave-it second-period offer. This offer is more complex than a single price since the firm's action after signing the second-period contract is not restricted to a 0-1 production decision. The offer more generally consists of an incentive scheme designed to induce the firm to choose the right scale of production (Baron-Myerson [1982], Guesnerie-Laffont [1982], Sappington [1982]) and/or the right level of effort (Laffont-Tirole [1984]). If we add an (unobservable) first-period choice of investment in these models, proposition 1 below applies[9]. Regulation under asymmetric

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[7]For example, when bargaining consists of a sequence of offers and counteroffers and the cost of bargaining is due to discounting, a party will never accept an offer that gives it a negative surplus. Nor will it in general make an offer that gives it a negative surplus and that is accepted with some probability.

[8]Under symmetric information, trade in general is optimal. So property number two does not bite. Property number one is also affected. Imagine for instance that the seller makes a take-it-or-leave-it offer. Under incomplete information, the derivative of Φ_2 with respect to c_2 is equal to the probability of trade (possibly with a discount factor if bargaining is sequential). Under complete information, it is equal to zero (as well as Φ_2). Because of the change in the information structure, the firm is not a residual claimant for its cost savings. For the same reason A2) also applies to Rubinstein [1982]'s bargaining scheme under complete information.

[9]Baron-Besanko [1984] and Laffont-Tirole [1984] offer two alternative, but related, reasons why a proposition similar to proposition 1 may apply when the firm makes an ex-post (after contracting) investment.

information is a special instance of a mechanism design. Assumption A2) and proposition 2 would equally apply to the case of workers investing in skills and facing an income tax which is not contingent on their skill level, or to that of consumers of a good produced by a monopolist, who invest in a consumption related activity in an unobservable way.

Let $\bar{e}_1$ denote the equilibrium investment (if the firm plays a mixed strategy over investment levels, the following proposition should read: "For any equilibrium investment $\bar{e}_1$, ...").

<u>Proposition 1</u>: Under assumptions A1) and A2), the firm invests too little in the relationship: $\bar{e}_1 < e_1^*$, where e_1^* is the first best level.

<u>Proof</u>: In the first period, the firm maximizes:

$$\max_e \{-e_1 + \gamma E(\Phi_2(\tilde{C}_2(e_1), \bar{e}_1))\}.$$

The first-order condition is

$$-1 + \gamma E\left(\frac{\partial \Phi_2}{\partial c_2} \frac{\partial \tilde{C}_2}{\partial e_1}\right) = 0$$

$$-1 - \gamma E(\Pr\{\tilde{V}_2 > \tilde{C}_2(e_1)\} \frac{\partial \tilde{C}_2}{\partial e_1}) > 0.$$

$$-1 - \gamma \int_{\{\tilde{V}_2 > \tilde{C}_2(e_1)\}} \frac{\partial \tilde{C}_2}{\partial e_1} > 0.$$

A1) then implies that $\bar{e}_1 < e_1^*$. Q.E.D.

Indeed if the bargaining process is inefficient (the level of implementation is strictly suboptimal), the firm invests strictly too little in the relationship. This is the case in the bargaining processes mentioned above.

The intuition behind proposition 1 is as simple as its proof. If bargaining reduces the probability of implementation relative to commitment, the acquisition of cost-reducing technology is not as valuable as in the first best, and the firm underinvests.

The underinvestment result is of course one of the main concerns of Williamson [1975]'s book. Williamson has forcefully argued that "opportunism" (i.e., renegotiation) is a threat to the accumulation of specific assets (see also Klein-Crawford-Alchian [1978]). Underinvestment results have also been found in Grout [1984] and Grossman-Hart [1984, section 3]'s models of bargaining under symmetric information.[10] Proposition 1 and the discussion of assumption A2) show that Williamson's result has considerable generality (in terms of bargaining schemes and ex-post information) when investment is not observable.

5) Observable investment

Let us now assess the effect of the unobservability of investment. To this purpose assume that e_1 is observed by the sponsor and is jointly determined. Since the two parties have transferable utilities, they will maximize their joint value. In our model the way the investment is financed is irrelevant to the choice of its level (this need not be true for more sophisticated models. For instance, the financing may affect the firm's debt

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[10] In these two models, investment is unobservable or at least cannot be contracted upon. The second period information is symmetric, but not observable by a third party. Grout uses the generalized Nash bargaining solution. In Grossman-Hart bargaining consists in a take-it-or-leave-it offer about quality, the price having been determined ex-ante.

level; if bankruptcy is an issue in the second-period, bargaining will be affected.)

We stick to our assumption that various transaction costs (design changes) and individual rationality constraints preclude the use of full commitment and require renegotiation: when signing a contract, the two parties can only agree on the level of investment and its financing.

Do the parties agree on a higher or lower level of investment than the one ($\bar{e}_1$) the firm chooses when its investment is not observable by the sponsor? A rough analysis of the comparison goes like this: increasing e_1 reduces the firm's cost and has a positive externality on the sponsor because it strengthens the latter's bargaining power. Because the firm ignores this externality, there is the usual presumption of underinvestment. The real story however is more complicated than this. Moving from unobservability to observability, one also changes the information structure in the bargaining process. The sponsor's beliefs about the firm's cost distribution change; so does the bargaining outcome for given value and cost levels.

Before making an assumption that allows comparison, let us give some notation. Let $\Phi_2(c_2,e_1)$ denote as before the firm's second period expected profit (over the sponsor's values) in the bargaining process when it has cost c_2 and the sponsor believes investment e_1 has been made. (For notational ease, we confine ourselves to point distributions for e_1 -- see proposition 2). Similarly $\psi_2(c_2,e_1)$ denotes the sponsor's expected profit (over all its potential values) when the first has cost c_2 and the sponsor believes investment e_1 has been made. For simplicity we restrict ourselves to bargaining schemes that do not involve delay in agreement, if any, or bargaining costs(one party's making an offer is an example of such a bargaining scheme). We will say that there is "more agreement (trade)" when "the set of values and costs such that agreement is reached becomes larger". We will say that "the sponsor prefers low costs" if $\psi_2(c_2,e_1)>\psi_2(c_2', e_1)$ for $c_2<c_2'$.

A3) i) The sponsor prefers low costs.

ii) There is at least as much agreement when the investment the sponsor believes the firm has made increases (keeping the firm's real cost distribution constant).

To give an example of a bargaining process that satisfies A3), suppose that the firm makes a take-it-or-leave-it offer: A3ii) is trivially satisfied, as the firm's optimal offer, for a given cost level, depends only on the distribution of the sponsor's value. So there is the same amount of agreement. A3i) -- (on average) the sponsor prefers the firm's cost to be low -- results from the fact that the firm's offer is an increasing function of its cost.

Proposition 2: Under assumption A3), $\bar{\bar{e}}_1 \geq \bar{e}_1$, where $\bar{\bar{e}}_1$ denotes an optimal (mutually agreed upon) investment level under investment observability, and $\bar{e}_1$ denotes a pure strategy equilibrium investment level under unobservability (if these exist. If either $\bar{e}_1$ or $\bar{\bar{e}}_1$ are random variables, the same property holds for the upper and lower bounds of their respective supports.)

Proof: See Appendix 1.

Proposition 2 gives a sufficient condition for investment to be greater under observability. Assumption A3i), the basis for our intuition, is fairly natural and is likely to be satisfied in most situations. Assumption A3ii) however is very strong. To see why, imagine that the sponsor makes a take-it-or-leave-it offer (note that this bargaining scheme satisfies A3i)). Imagine further that higher values of c_2 signal lower values of e_1. In technical terms this can be expressed by the assumption that the conditional cumulative distribution function $F(c_2 \mid e_1)$ (with density $f(c_2 \mid e_1)$) has the decreasing hazard rate property: $\frac{\partial}{\partial e_1}\left(\frac{f(c_2 \mid e_1)}{F(c_2 \mid e_1)}\right)<0$. It is easily shown that the sponsor's price $p_s(v_2,e_1)$ decreases with the sponsor's beliefs about e_1[11]. So, for a given distribution of the firm's cost, more optimistic beliefs about e_1 make the sponsor tougher and lead to less agreement. Hence the change in the sponsor's information associated with an increase in e_1 will make investment less attractive. Appendix 1 presents such an example in which this "<u>information effect</u>" dominates the "<u>externality effect</u>" so that <u>investment is lower under investment observability</u>: $\bar{\bar{e}}_1<\bar{e}_1$. So no general conclusion can be drawn at this stage about the relative sizes of investment under observability and non observability.

Note that if we remove our assumption that c_2 and v_2 are private information, so that the two parties bargain under <u>symmetric information</u>, we

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[11]The sponsor, when it has a valuation v_2, chooses a price p such that $\max_p (v_2-p)F(p \mid e_1)$.

The first order condition is

$$(v_2-p)f(p \mid e_1)-F(p \mid e_1)=0 .$$

Writing the second-order condition, which, we assume, is satisfied, and using the first-order condition gives

$$\frac{\partial p}{\partial e} \propto (v_2-p)\frac{\partial f(p \mid e_1)}{\partial e_1} - \frac{\partial F(p \mid e_1)}{\partial e_1} \propto \frac{\partial f(p \mid e_1)/\partial e_1}{f(p \mid e_1)} - \frac{\partial F(p \mid e_1)/\partial e_1}{F(p \mid e_1)}$$

$$\propto \frac{\partial}{\partial e_1}\left(\mathrm{Log}\,\frac{f(p \mid e_1)}{F(p \mid e_1)}\right)<0,$$

where $\propto$ stands for "proportional to".

eliminate the information effect and A3ii) is satisfied: thus if the sponsor prefers low costs, $\bar{\bar{e}}_1 > \bar{e}_1$. Indeed, common bargaining processes are in general efficient under symmetric information, so that $\bar{\bar{e}}_1 = e_1^*$.

One may wonder if one could not at least prove that investment under observability is always lower than the first best level. However this assertion is also false. Appendix 1 constructs an <u>example in which the two parties overinvest relative to the first best</u>: $\bar{\bar{e}}_1 > e_1^*$. In this example a cost reduction considerably softens the firm's behavior in the bargaining process, and confers strong positive externalities on the sponsor. The parties are then willing to invest beyond the first best level to reduce undertrade.

Lastly we consider the case in which the first-period investment is <u>observable, but not verifiable</u> (in the spirit of Holmström [1982]). This means that e_1 can be observed by the sponsor, but not by a third party (court), and therefore cannot be jointly determined. We compare the new investment level ($\tilde{e}_1$) to the unobservable one ($\bar{e}_1$). The difference between the two levels is due uniquely to the information effect; the firm picks the investment, and does not internalize the positive bargaining externality on the sponsor. The following proposition, proved in Appendix 1, hence is not surprising:

<u>Proposition 3</u>: Assume the investment is observable, but not verifiable; and that, for a given second-period cost, the firm prefers that the sponsor believes the investment was low (i.e., $\Phi_2(c_2, e_1)$ does not increase with e_1); then the firm invests less than under investment unobservability: $\tilde{e}_1 < \bar{e}_1$ (if the firm plays a mixed strategy under unobservability, then $\tilde{e}_1 < \sup \bar{e}_1$.)

Proposition 3 applies for instance to the case in which the sponsor makes a take-it-or-leave-it offer and the cum ulative distribution function of the firm's cost has the decreasing hazard rate property (see footnote 11).

6) Cancellation fees.

We now assume that a third party (court) can observe whether trade occurs, and that the cost of doing so is sufficiently small so that payments contingent on trade can be specified in the first-period contract. In this section we consider only payments made if no trade occurs.

Cancellation fees have been advocated in the literature as a way to reintroduce some commitment in relationships that are otherwise governed by sequential renegotiation. The party that commits itself to paying a fee if it "cancels" the project to some extent internalizes the cost it inflicts on the other party[12]. The U.S. Department of Defense has been advocating cancellation fees for some time as a way to reduce procurement costs. Its main argument is that the contractors have more incentive to invest in cost-reducing technology if they know that the government (Congress) is less tempted to act opportunistically once the investment is made (see Thaler-Ugoff [1982] for a discussion).

Cancellation fees are popular because they are easily enforceable clauses: termination of a project can often be observed by a third party. On the other hand it is very hard to know who is really responsible for the cancellation. The party that cancels may have been forced to do so by excessive demands from the other party. The very reasons that make long-run

[12]Here I consider only self-inflicted penalties. There is a large law and economics literature on legal remedies in the event of a breach of a contract (see, e.g., Shavell, [1980,1984]).

contracting impossible in general also work against a fair splitting of responsability between the two parties by a third party. This is the clue to why cancellation fees may not be as attractive as they look. Indeed the purpose of this section is to show that the Department of Defense view is not correct in general as it misses a crucial element: a cancellation fee influences the bargaining process by increasing the firm's power.

Consider the two-period model set up in section 2. Assume that the investment e_1 is not observed by the sponsor; and that a cancellation fee $K>0$ has to be paid by the sponsor to the firm in case of no trade. For simplicity, we assume that bargaining involves no delay (for instance, one of the parties makes a take-it-or-leave-it offer) and that K must be paid immediately after disagreement occurs. Performance bond requirements, i.e., bonds that are posted by the firm and are given up in case of non-delivery, can be formalized as negative cancellation fees. Contrary to cancellation fees, such bonds are rarely observed (see Scherer [1964]).

Assume first that the two parties have linear utilities, as has been assumed up to now. The sponsor (firm) then bargains with fictitious value (v_2+K) (cost (c_2+K)). This bargaining is equivalent to that between a sponsor with value v_2 and a firm with cost c_2 over a fictitious price $q\equiv p-K$. The probability of agreement (trade) is the same as for $K=0$; and hence the incentive to reduce cost is the same. In other words the cancellation fee has a redistributive effect (it increases the firm's income by K in all states of nature), but no allocative effect. We do not develop this point further as it will result from the analysis of a special case in the two examples below.

We now want to show that a cancellation fee can decrease investment. To this purpose a) we assume that the firm is risk-averse and b) we consider two very special second-period bargaining processes. One gives a lot of power to the firm and the other to the sponsor. In both cases it is shown that investment can decrease with the cancellation fee.

Example 1: The firm makes a take-it-or-leave-it offer. Let us assume that the firm has utility function $\{U_1(-e_1)+\gamma U_2(p-c_2)\}$ if investment e_1 is made in the first period and agreement is reached at price p in the second period. If disagreement occurs, the firm's utility is $\{U_1(-e_1)+\gamma U_2(K)\}$ where K is the cancellation fee. U_1 and U_2 are concave. Also for simplicity we assume that the sponsor knows the value of the project with certainty at the beginning of the second period.

Proposition 4: Assume that the firm makes the second-period offer. If its second-period utility function is linear (resp. exhibits constant absolute risk aversion), its first-period investment is independent of (resp. decreases with) the cancellation fee.

Proof: See Appendix 2.

We already gave the intuition in the risk-neutral case. When the firm is risk-averse, two new effects are introduced. First the cancellation fee raises the firm's income when trade occurs (as well as when it does not). Therefore the marginal utility of income in the case of trade goes down and cost reduction becomes less advantageous for a given probability of trade. The second effect is due to the change in the probability of trade and is in general ambiguous. But note that if the firm simply tacks the cancellation fee onto its best offer without cancellation fee, its income is increased by K whether trade occurs or not. It is easy to see that if the firm has a constant absolute risk aversion second-period utility function, a uniform increase in income does not modify its pricing decision problem. So the probability of trade in unaffected and the first effect implies that investment decreases with the cancellation fee.

Example 2: The sponsor makes a take-it-or-leave-it offer. The analysis is very similar to that of example 1, and will only be mentioned here. It is also possible to show that, for a given level of cost, the effect of a cancellation fee on trade is in general ambiguous. But if the sponsor is risk neutral, the probability of trade does not depend on K. Furthermore, if $c_2=\Theta_2 h(e_1)$ where Θ_2 is uniformly distributed and h is decreasing, a strictly risk-averse firm invests strictly less when the cancellation fee increases (see Appendix 2).

On the basis of these two examples, it is not clear that a cancellation fee induces investment in the relationship. First, it makes the firm more demanding in the bargaining process as well as making the sponsor more conciliatory. Second, it reduces the firm's second-period marginal utility of a risk-averse firm. These two points lead to two important remarks:

Remark 1. One would want to reduce the sponsor's bargaining power without increasing the firm's. This is achieved if the firm receives only a fraction of what the sponsor loses in case of cancellation. This point is nicely made in a somewhat different context (see below) by Williamson who notices that "a king who is know to cherish two daughters equally and is asked for screening purposes to post a hostage is better advised to offer the ugly one" ([1983], p.527). Such contracts however are rarely observed, as there is an ex-post common incentive to disguise cancellation in order to avoid an aggregate loss.

Remark 2. Risk aversion raises the question of the intertemporal smoothing of the firm's income. This problem is studied by Crawford in a two-period renegotiation model. One of the parties makes a first-period investment; and the two parties bargain in the second period about the common use of this investment. The emphasis is not on incentive problems (there is no explicit informational asymmetry), but on the interference of future individual rationality constraints or bargaining with the parties' intertemporal smoothing of income. In Crawford's paper the absence of commitment and capital markets prevents intertemporal smoothing of profits and utilities. This affects the intertemporal path of marginal utilities of profits and thus the desirability of investment. Crawford shows that there is no presumption for underinvestment. As in section 4 we ruled out the need for intertemporal smoothing of income, the Crawford effect did not arise and we did obtain underinvestment, at least if investment is not observed by the sponsor.

Williamson [1983] has studied the role of "hostages" in ensuring a right amount of specific investment. In his model as in Crawford's, investment can be observed by both parties. The firm (in my terminology) can either not invest in the relationship and later use a costly general purpose technology, or invest some fixed and positive amount in specific skills or machinery. It is assumed that in a first-best world this investment is desirable. Only the "sponsor"'s ex-post (second period) value is private information; it makes a take-it-or-leave-it offer to the firm in the second period. Efficiency arises if the sponsor posts a bond <u>equal to</u> the specific investment and loses it to the firm if the firm has actually made the investment <u>and</u> the project is cancelled. So if the specific investment is made, the firm's second-period income is raised by the amount of the bond, i.e., of the investment, in all states of nature (as suggested by this section, this property holds for more general bargaining schemes and for bilateral asymmetric information). Furthermore the level of trade is efficient, as it is independent of the size of the bond, and the sponsor, who makes the offer, has full information about the firm. Hence the firm has no incentive not to invest at the first best level.

My conclusion on the role of hostages (cancellation fees) differs considerably from Williamson's. The main difference is that I posited that specific investment is not observable by the sponsor. Then the size of the hostage cannot depend on the level of specific investment, which suppresses the channel through which an hostage gives the right incentive to invest. Indeed I argued that there is no presumption that hostages encourage specific investment at all.

When specific investment is observable by the sponsor, then the two parties can agree on how to share its cost (compensation in advance). In our model the hostage technology is a roundabout way to do so. Under investment observability, the main issue may not be the financing of the investment cost, but the determination of its level (see section 5).

7. Price-fixing and cost overruns.

a) Price-fixing: The analog of a cancellation fee in case of termination is the ex-ante fixation of the price to be paid by the sponsor in case of agreement. In this section we present a preliminary analysis of price-fixing, assuming that the firm's investment is not observed.

The meaning of a price agreement is a subtle issue. "Trade, if any, takes place at price p" is not a complete decision rule. Second-period gains from trade must also be identified, so that some information must be acquired to decide on whether to trade (unless trading is decided in advance, which is usually not a very flexible or efficient contract).

Let us first assume that the third party can observe all monetary transfers between the sponsor and the firm, and that the first-period contract makes the commitment to the initial price credible (for instance by having both parties pay a large sum to a third party if they trade at a different price). The only purposeful bargaining then concerns the trading decision. The only way to use decentralized information, is then to give a veto power to one or two of the parties (unless the choice of another attribute, e.g., quality, is at stake). These types of second-period decision rules are studied in Grossman-Hart [1984]. The advantages of such contracts are that they make little use of the third party (thus saving on the cost of contracting associated with a priori more efficient contracts involving a trading price contingent on message transfers); and that they lead to a quick decision (thus saving on the bargaining costs that may arise under unconstrained second-period bargaining if there is asymmetric information).

Such simple decision rules are not in general ex-post efficient. So the two parties in general have an incentive to renegotiate. Still assuming that the third party can monitor all transfers, it may pay the two parties to leave some flexibility in the contract by allowing them to recontract ex-post. One may then wonder what price-fixing means. Consider first the case of a fully rigid trade price and a fully flexible no-trade price. Roughly the first-period contract then takes the form: "Both parties must trade at the fixed price, unless they reach an agreement not to trade and choose a cancellation fee.". This type of contract is reminiscent of the ones studied in section 6, in which the no-trade price was fully rigid and the trade price fully flexible. Indeed it is easy to build bargaining schemes such that, if the parties are risk neutral, the fixation of the trade price has a redistributive, but no allocative effect (suppose that one of the parties makes a take-it-or-leave-it offer over the no-trade price and assume that bankruptcy cannot occur.). A more interesting situation arises when either the first-period contract stipulates that the trade price can be jointly modified or the courts accept to enforce renegotiated contracts over the initial one. The possibility of renegotiation however needs not make the first contract vacuous. Hart-Moore [1985] design a contract and an extensive form for the renegotiation of the contract such that the initial price does put a constraint on the renegotiation process without imposing too much inflexibility the way the completely fixed price contract does. In their model, the initial contract does more than redistributing second-period income by changing the status-quo outcome. It also affects first-period investment even if the parties are risk neutral. The study of constrained renegotiation seems a promising topic for future research, since such set-ups are intermediate between -- and often more realistic than -- the polar cases of completely fixed price (Grossman-Hart) and unconstrained bargaining (sections 4 and 5 of this paper). It also sheds some light on the issue of cost overruns, as the two examples below demonstrate.

b) Cost Overruns. Cost overruns have always been a concern to economists and politicians. Peck and Scherer estimate that for U.S. defense programs developments costs exceed original predictions by 220% on average; in some cases costs have exceeded original predictions by as much as 14 times ([1962], p.412,429). More recent estimates in different countries as well as the recent political debate in the U.S. about military spending also indicate that procurement costs are a serious problem.

An economist's natural analysis of cost overruns is that costs may be "high" due to agency problems, but that in a Rational Expectations world they are not unforeseen on average. The study of renegotiation suggests that high costs result from the related problems of ex-post bilateral monopoly and underinvestment. Ex-ante asymmetric information (not considered in this paper) would also create inefficiencies. But the sponsor ought to anticipate all these inefficiencies.

As noticed above, the fundamental question about "systematic unforseen cost overruns" is the meaning of original cost estimates, i.e., the level of commitment attached to these estimates. In particular, what is the status of an original price estimate when the parties know that the firm will bear only a small share of overruns, as seems to be the case for military procurement?

One hypothesis is that the original price estimate represents only a lower bound on the transfer in case of implementation. It would then be a minimum commitment from the sponsor. This interpretation is in the spirit of "redeterminable fixed-price contracts", in which the partners negotiate a tentative base price and then, after some share of expected costs has been incurred, renegotiate a new price. To give an example, imagine that production can occur at different levels of quality/design. In period one, when the contract is signed, only one design, q_0, is known to all the parties (including the court) and can be contracted for. q_0 represents the current technology. The firm must invest to be able to produce design q_0. In the investment process, the firm may discover a new and superior design q_1. The initial contract can specify a minimum price p_0 that the sponsor must pay conditional on the firm's producing design q_0. Such a price encourages the firm to invest, by making sure that the sponsor does not reap all gains from trade once investment is sunk. If design q_1 comes about, the firm and the sponsor can renegotiate a new contract to share the gains from trade. If the firm has any bargaining power, the new price p_1 will naturally exceed the initial price, even if the new design involves the same production cost as the old one (For instance, if the traders use the Nash-Rubinstein bargaining scheme, and q also measures the seller's valuation: $p_1-p_0=\frac{q_1-q_0}{2}$.)

A similar effect can be obtained by adding both first-period price fixing and the possibility of the firm's going bankrupt or quitting in the second period to our model. Suppose that in the second period the sponsor makes a take-it-or-leave-it offer and that if the firm rejects this offer and does not quit, the parties are constrained to trade at the agreed upon price p_0; and for simplicity that the firm's revealed second-period cost c_2 is observed by the sponsor. In bad states of natures $(c_2>p_0)$, the sponsor must raise the price to c_2 so that the firm breaks even in the second-period. The minimum price however has content in good states of nature $(c_2<p_0)$, and may induce the firm to invest in the relationship.

We thus conclude that cost overruns can be derived either from the upward trend in quality or from the firm's threat of quitting the relationship.

Remark: We believe that the description of procurement as a two-tier relationship, if enlightening, is fairly restrictive. If higher-order hierarchies are considered, the supervisor and the agent may well have common interests. In the case of military procurement for instance, it is well-known that the services' (Délégation Générale à l'Armement in France or Department of Defense in the U.S.) interests do not coincide with the nation's. To quote Scherer ([1964],p.28): "As the advocates of new programs, government operating agencies have often encouraged contractors to estimate costs optimistically, recognizing that higher headquarters might be shocked out of supporting a program whose true costs were revealed at the outset"; and Peck-Scherer ([1962], p.412): "There is a tacit assumption (between the services and the contractors) that 'we'll work with this low figure for a while. If the program looks good, we can go back later and get an increase'". This however does not mean that cost overruns are unforseen (except officially) by higher headquarters or the Congress. One may think of the Government Agency and the Congress as playing a revelation game with non-identical preferences (in the style of Crawford-Sobel [1982] and Green-Stokey [1980]). Such a game typically has many equilibria, some of which give rise to phenomena resembling grade (or letters of recommendation) inflation.

Appendix 1

• Proof of proposition 2:

Let $\bar{e}_1$ denote an equilibrium investment for the firm under non-observability. And let $\bar{\bar{e}}_1$ denote an optimal investment under observability. We consider only point distributions for $\bar{e}_1$ and $\bar{\bar{e}}_1$ (the same proof goes through by taking expectations over these variables as long as inf $\bar{e}_1$>sup $\bar{\bar{e}}_1$ if these are random variables.) Assume $\bar{e}_1>\bar{\bar{e}}_1$. From the definitions of $\bar{e}_1$ and $\bar{\bar{e}}_1$, we have:

$$\text{(A1)} \qquad E\{\gamma\Phi_2(\tilde{C}_2(\bar{e}_1),\bar{e}_1)\}-\bar{e}_1 \geq E\{\gamma\Phi_2(\tilde{C}_2(\bar{\bar{e}}_1),\bar{e}_1)\}-\bar{\bar{e}}_1$$

$$\text{(A2)} \qquad E\{\gamma\Phi_2(\tilde{C}_2(\bar{\bar{e}}_1),\bar{\bar{e}}_1)+\gamma\psi_2(\tilde{C}_2(\bar{\bar{e}}_1),\bar{\bar{e}}_1)\}-\bar{\bar{e}}_1$$
$$\geq E\{\gamma\Phi_2(\tilde{C}_2(\bar{e}_1),\bar{e}_1)+\gamma\psi_2(\tilde{C}_2(\bar{e}_1),\bar{e}_1)\}-\bar{e}_1 .$$

(A1) takes into account the fact that under non-observability, the firm can influence its cost distribution, but not the sponsor's beliefs about it (which are derived from the equilibrium investment $\bar{e}_1$).

Adding (A1) and (A2) and using A3i) gives:

$$\text{(A3)} \qquad E\{\Phi_2(\tilde{C}_2(\bar{\bar{e}}_1),\bar{\bar{e}}_1)+\psi_2(\tilde{C}_2(\bar{\bar{e}}_1),\bar{e}_1)\}$$
$$>E\{\Phi_2(\tilde{C}_2(\bar{\bar{e}}_1),\bar{e}_1)+\psi_2(\tilde{C}_2(\bar{\bar{e}}_1),\bar{e}_1)\}$$

Note that in (A3) the only difference between the LHS and the RHS is the sponsor's beliefs about the firm's investment. Also

$$\Phi_2(c_2,e_1)+\psi_2(c_2,e_1)=E_{v_2}\left((v_2-c_2)1_{\{\delta(v_2,c_2 \mid e_1)=A\}}\right) \text{ where}$$

$1_{\{\delta(v_2,c_2 \mid e_1)=A\}}$ is equal to one when there is agreement and to zero in case of disagreement. A3ii) can be written:

$$\delta(v_2,c_2 \mid \bar{\bar{e}}_1)=A \rightarrow \delta(v_2,c_2 \mid \bar{e}_1)=A.$$

This contradicts (A3). Q.E.D.

• Example in which observability reduces the investment.

Assume that the sponsor makes a take-it-or-leave-it offer in the second period. The sponsor has known value v_2. The firm may have one of two costs $\underline{c}_2$ or $\bar{c}_2$ with $\underline{c}_2<\bar{c}_2<v_2$. There are two investment technologies. The cheap one does not involve any first-period expense and leads to cost $\bar{c}_2$. The expensive one costs $e_1>0$, and leads to cost $\underline{c}_2$ with probability α, and to cost $\bar{c}_2$ with probability $(1-\alpha)$. There is no discounting. Let us assume that

(A4) $v_2-\bar{c}_2<\alpha(v_2-\underline{c}_2)$

(A5) $v_2-\bar{c}_2>\alpha(v_2-\underline{c}_2)-e_1$.

(A4) says that, if the sponsor knows that the firm has chosen the expensive technology, it plays "tough" (offers $\underline{c}_2$). (A5) then implies that, under investment observability, the optimal level of investment is $\bar{\bar{e}}_1=0$ (cheap technology).

Next assume that

(A6) $\alpha(\bar{c}_2-\underline{c}_2)>e_1$

and define x and y by

$$v_2-\bar{c}_2=\alpha x(v_2-\underline{c}_2)$$

$$\alpha y(\bar{c}_2-\underline{c}_2)=e_1$$

x and y belong to (0,1) from (A4) and (A6). Assume now that investment is not observable by the sponsor. The following is then a mixed strategy equilibrium: the firm chooses the expensive technology $(\bar{e}_1=e_1)$ with probability x, and the cheap one $(\bar{e}_1=0)$ with probability (1-x). The sponsor charges $\bar{c}_2$ with probability y and $\underline{c}_2$ with probability (1-y).

Lastly to check that conditions (A4), (A5) and (A6) are not inconsistent, take $\{v_2=4;\ \bar{c}_2=3;\ \underline{c}_2=1;\alpha=\frac{1}{2};\ e_1=.75\}$.

- Example in which the investment under observability exceeds the first best level.

The sponsor's value can be either $\underline{v}_2$ or $\bar{v}_2$ ($\underline{v}_2<\bar{v}_2$) with equal probabilities. The investment technology is deterministic. There are two levels of cost $\underline{c}_2<\bar{c}_2(<\underline{v}_2<\bar{v}_2)$. The investment cost for $\underline{c}_2(\bar{c}_2)$ is $e_1(f_1)$: $e_1>f_1$. Assume that

(A7) $\underline{v}_2-\underline{c}_2>\frac{1}{2}(\bar{v}_2-\underline{c}_2)$

(A8) $\frac{1}{2}(\bar{v}_2-\bar{c}_2)>\underline{v}_2-\bar{c}_2$

(A9) $e_1+\underline{c}_2=f_1+\bar{c}_2+\varepsilon$

where $\varepsilon>0$ is "small"[13].

(A9) implies that the first-best investment is $e_1^*=f_1$. Assume that the firm makes a take-it-or-leave-it offer. From (A7), it makes offer $\underline{v}_2$ if its cost is $\underline{c}_2$, so there is the optimal level of implementation. If its cost is $\bar{c}_2$, it makes offer $\bar{v}_2$ (from (A8)), and there is suboptimal implementation. To determine $\bar{\bar{e}}_1$, we have to compare social welfare for the two possible investments:

Investment e_1: $\frac{1}{2}(\bar{v}_2+\underline{v}_2)-(\underline{c}_2+e_1)\equiv A$

Investment f_1: $\frac{1}{2}\bar{v}_2-\frac{1}{2}\bar{c}_2+f_1\equiv B$

Clearly A-B>0. So the second-best investment under observability may exceed

[13] For example $\{\underline{c}_2=1;\ \bar{c}_2=2;\ \underline{v}_2=3;\ \bar{v}_2=4.5;\ e_1=1.1;\ f_1=0\}$.

the first best level. The point is that it may be worth forcing the firm to overinvest in order to "soften" its behavior in the bargaining process, and confer positive externalities on the sponsor.

- Proof of Proposition 3:

From the definitions of $\bar{e}_1$ and $\tilde{e}_1$, we have

$$E(\Phi_2(\tilde{C}_2(\bar{e}_1), \bar{e}_1))-\bar{e}_1 \geq E(\Phi_2(\tilde{C}_2(\tilde{e}_1), \bar{e}_1))-\tilde{e}_1$$

and

$$E(\Phi_2(\tilde{C}_2(\tilde{e}_1), \tilde{e}_1))-\tilde{e}_1 \geq E(\Phi_2(\tilde{C}_2(\bar{e}_1), \tilde{e}_1))-\bar{e}_1.$$

Adding these two equations and using the assumption that Φ_2 is non-increasing in e_1 leads to proposition 3. If $\bar{e}_1$ is a random strategy rather than a pure strategy, then the same proof shows that sup $\bar{e}_1 \geq \tilde{e}_1$. Q.E.D.

* *

Appendix 2

Example 1

- Proof of proposition 4:

Let $G_2(v_2)(g_2(v_2))$ denote the cumulative distribution function (density) of the sponsor's value in period two.

If the firm makes an offer p, the sponsor acceps the offer if and only if $v_2-p \geq -K$. Therefore, in the second period, the firm maximizes:

$$\max_p \{(1-G(p-K))U_2(p-c_2)+G(p-K)U_2(K)\}$$

Letting $q \equiv p-K$ and optimizing over q gives the first-order condition:

$$\text{(A10)}\quad -g(q)(U_2(q+K-c_2)-U_2(K))+(1-G(q))U_2'(q+K-c_2)=0$$

I will assume that the second-order condition is satisfied; a sufficient condition for this is that the density g is non-decreasing everywhere. Let $q^*(c_2,K)$ denote the optimum and let $p^*(c_2,K)\equiv q^*(c_2,K)+K$.

(A10) implies that $q^*>c_2$ or $p^*>c_2+K$.

Notice that if U_2 is linear, $q^*(c_2,K)$ does not depend on K. Neither does the probability $\left(1-G(q^*(c_2, K))\right)$.

Let us now assume that $U_2$is strictly concave. Differentiating the first-order condition and using the first- and second-order conditions gives:

$$\text{(A11)}\quad \frac{\partial q^*}{\partial K} \propto \left(\frac{U'(K)-U'(q^*+K-c_2)}{U(q^*+K-c_2)-U(K)}\right) - \left(\frac{U''(q^*+K-c_2)}{U'(q^*+K-c_2)}\right);$$

and p^* is easily shown to grow with K.

Thus the sign of $\frac{\partial q^*}{\partial K}$ is a priori ambiguous.

In particular if $\frac{\partial q^*}{\partial K}>0$, then a cancellation fee reduces trade even more ($G(q^*)$ increases). This is the case for example for a logarithmic U_2.

Let us now investigate the effect of a cancellation fee on first-period investment. Using the envelope theorem, e_1 is given by:

In particular if $\frac{\partial q^*}{\partial K}>0$, then a cancellation fee reduces trade even more ($G(q^*)$ increases). This is the case for example for a logarithmic U_2.

Let us now investigate the effect of a cancellation fee on first-period investment. Using the envelope theorem, e_1 is given by:

$$-U_1'(-e_1)-\gamma E[(1-G(q^*(c_2,K)))U_2'(q^*(c_2,K)+K-c_2)\frac{\partial \tilde{c}_2}{\partial e_1}]=0 \ .$$

Assuming that the second-order condition is satisfied, we obtain:

$$\text{(A12)} \quad \frac{\partial e_1}{\partial K}\alpha\gamma E[g(q^*)\frac{\partial q^*}{\partial K}U_2'\frac{\partial \tilde{c}_2}{\partial e_1} -(1-G(q^*))U_2''\frac{\partial p^*}{\partial K}\frac{\partial \tilde{c}_2}{\partial e_1}] \ .$$

Note that if U_2 is linear, the cancellation fee has no influence on investment. Assuming now that U_2 is strictly concave, we can distinguish two terms inside the expectation in (A12).

- The first term corresponds to the change in trade. If the cancellation fee reduces implementation $(\frac{\partial q^*}{\partial K}>0)$, it also tends to reduce investment (as $\frac{\partial \tilde{c}_2}{\partial e_1}<0$).
- The second term unambiguously leads to less investment (as $\frac{\partial p^*}{\partial K}>0$, $\frac{\partial \tilde{c}_2}{\partial e_1}<0$, $U''_2<0$). The point is that a cancellation fee increases the price. Therefore it decreases the marginal utility of income for the firm in case of agreement, and thus reduces the desirability of cost-reducing investment.

Let us now examine the special case of a constant absolute risk aversion U_2: $U_2(x)=-e^{-\theta x}(\theta>0)$.

(A11) implies that $\frac{\partial q^*}{\partial K}=0$, so that implementation does not depend on the cancellation fee. The analysis of (A12) then implies that $\frac{\partial e_1}{\partial K}<0$. Q.E.D.

- <u>The sponsor makes a take-it-or-leave-it offer.</u>

Let F (resp. f) be the cumulative distribution (resp. density) of the firm's cost conditional on the firm making its first period <u>equilibrium</u> investment $\bar{e}_1$. A risk-neutral sponsor chooses $q=p-K$ so as to maximize $\{(1-F(q))(-K)+F(q)(v_2-q-K)\}$. The optimal $q^*(v_2,K,\bar{e}_1)$ therefore does not depend on K. Neither does it depend on the firm's actual investment, which is private information. Second the firm's equilibrium investment is given by:

$$\text{(A13)}\quad -U_1'(-e_1)-\gamma\int_{\{q^*(v_2,\bar{e}_1)>c_2\}} U_2'(q^*(v_2,\bar{e}_1)+K-c_2)\frac{\partial \tilde{C}_2}{\partial e_1}=0.$$

Note that in a rational expectations equilibrium, $e_1=\bar{e}_1$. If $\tilde{C}_2=\Theta_2 h(e_1)$, where h is decreasing and convex and Θ_2 is uniformly distributed, then the <u>total</u> derivative of (A13) with respect to e_1 is negative. As its derivative with respect to K is also negative, the first period investment decreases with the cancellation fee.

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