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. Last, 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.

I. 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 responsibility 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 II 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, and the sponsor learns its value for the project. Both data are private information. The two parties then bargain (non-cooperatively) over the price and whether to trade.

Section III 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 other 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 III 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 IV, 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 a complete contract ("first-best" level). This formalizes Williamson’s (1975) idea that "opportunism" leads to under-investment in the relationship.

Section V assumes that the investment can be observed by the two parties. They meet in the first period and jointly decide on the firm’s investment level (and on the investment sharing rule). To remain consistent with the assumption of no long-run commitment, I assume that the two parties can specify only the first-period investment; that is, they cannot constrain the future negotiation (see Sec. III for situations that the assumption of short-run commitment might represent). It is shown that the mutually agreed-on investment may be lower than its level under nonobservability, higher than the first-best level, or intermediate between the two values. A sufficient but strong condition for bargaining is given for the investment under observability to exceed that under nonobservability. Section V also studies the case of an investment that is observable by the two parties but not verifiable by a court.
Sections VI and VII assume that a contract is signed in the first period and that this contract is incomplete; 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, which 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 there is one. This assumption is closely related to the motivation behind incomplete contracts. Section VI 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 since 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 VII, which also discusses the concomitant and important notion of cost overruns.

II. 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 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 \(\Theta\) is a random variable and \(C_2\) is differentiable and decreasing in \(e_1\). For simplicity, I 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

\(^1\) Cancellation fees are very similar to Shavell’s (1980, 1984) damage payments and to Williamson’s (1983) hostages.

\(^2\) In fact, earlier restrictions on fees and, more generally, on multiyear procurement have been removed by the 1982 Defense Authorization Act.

\(^3\) This could be derived by assuming that the marginal cost reduction is infinite at zero: \((\partial C_2/\partial e_1)(0, \Theta) = -\infty\) for all \(\Theta\).
time 2, the sponsor learns its project $v_2 = V_2(\eta)$, where $\eta$ is a random variable. I assume that $\Theta$ and $\eta$ are independent and that their distributions, although not their realizations, as well as all other data are common knowledge. I thus assume that information is symmetric at date 1.\footnote{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.”} For notational simplicity I 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 presentation above, 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 learning, respectively, $c_2$ and $v_2$, the firm and the sponsor bargain noncooperatively over the price and whether to produce the good. As there is some leeway in specifying the way the parties bargain, I will either rely on general properties of bargaining equilibria or study more specific bargaining schemes to illustrate the main features.

Last, the two parties have identical discount factor $\gamma$ 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

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

I make an assumption ensuring that this maximization problem has a unique solution.

**Assumption 1.** $\Pi(e_1)$ is strictly concave.

The first-best investment is then uniquely defined by

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

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

### III. Discussion of the Model

**A. 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 somewhat looser, 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.

B. Commitment

The absence of commitment ought to be discussed, for it underlies the second interpretation explicitly and the first one implicitly. 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, I ought to warn the reader that the analysis here is very informal since it refers to considerations outside the scope of the model. I 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 into 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 and Scherer 1962, p. 417). Second, for risky research and development (R & D) projects, design changes are the rule rather than the exception. There exists ex ante a large number of such changes (assuming that 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. It is therefore not surprising that the necessity or desirability of design changes often triggers a renegotiation of the initial contract. (These arguments have less relevance for industries with more predictable technologies. See Joskow [1985] for evidence of long-term contracting between coal mines and electricity generating plants.)

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 in 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, rather than 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).

C. 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 of 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, they sometimes are not very informative. First, the project under consideration may be only one of several projects in which the firm is dealing with other sponsors or customers.

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5 The initial contract may still serve as a status quo point in the renegotiation over design changes (see Sec. VII).
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. And 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," that is, to assess the true costs of inputs (Peck and Scherer 1962, pp. 417, 514). Second, the firm's cost may reflect its (unobservable) opportunity cost. 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 and Tirole [1986]). 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 $e_1$, 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-on equipment. If investment is observable, and if the two parties meet in period 1, then they have a mutual interest in signing a contract specifying the level of investment (and its financing). I will, however, assume that, because of design changes or other reasons mentioned earlier, they can specify only the (short-run) investment decision in the contract.

IV. 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 me introduce some notation. For a given bargaining scheme and equilibrium of the corresponding bargaining game, let $\Phi_2(c_2, e_1)$

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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).
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 that 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 $(F_2, e_1)$, while the production cost $c_2$ does. Note also that $\Phi_2$ is an expectation over the sponsor's value and depends on the bargaining process. To clarify this notion, let me 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 $p \leq v_2$. 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, $p_f(c_2, e_1)$, 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 $p_*(v_2, \bar{e}_1)$ is given by

$$\max_p [(v_2 - p)pr(c_2 \leq p|\bar{e}_1)].$$

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

$$\Phi_2(c_2, \bar{e}_1) = \int_{\{v_2: p(v_2, \bar{e}_1) \geq c_2\}} [p_*(v_2, \bar{e}_1) - c_2].$$

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

**Assumption 2.** For almost all $c_2$, $\Phi_2(c_2, \bar{e}_1)$ is differentiable in $c_2$ and $|\partial \Phi_2/\partial c_2| \leq pr(v_2 \geq c_2)$.

Assumption 2 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 2 is clearly satisfied in the two examples above. When the firm makes a take-it-or-leave-it offer, the envelope theorem implies that \( \frac{\partial \Phi_2}{\partial c_2} = \text{pr}[\nu_2 \geq p_f(c_2, \bar{\epsilon}_1)] \). But \( p_f(c_2, \bar{\epsilon}_1) \geq c_2 \). So assumption 2 is satisfied. Similarly, when the sponsor makes a take-it-or-leave-it offer, \( \frac{\partial \Phi_2}{\partial c_2} = \text{pr}[p_s(\nu_2, \bar{\epsilon}_1) \geq c_2] \). As \( p_s(\nu_2, \bar{\epsilon}_1) \leq \nu_2 \), assumption 2 follows.

Assumption 2 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 counteroffers. 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, 1985), Fudenberg and Tirole (1983), Sobel and Takahashi (1983), Grossman and Perry (1984), Fudenberg, Levine, and Tirole (1985), and Rubinstein (1985). Assumption 2 is also satisfied for the Chatterjee and Samuelson (1983) simultaneous offer scheme, which implements (in the uniform case) the optimal mechanism with individual rationality constraints described in Myerson and Satterthwaite (1983).

In these games assumption 2 comes from the conjunction of two properties: (a) Incentive compatibility: The derivative of \( \Phi_2 \) 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. (b) 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

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. Under symmetric information, trade in general is optimal. So property \( b \) does not bite. Property \( a \) is also affected. Imagine, e.g., that the seller makes a take-it-or-leave-it offer. Under incomplete information, the derivative of \( \Phi_2 \) 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 \( \Phi_2 \)). Because of the change in the information structure, the firm is not a residual claimant for its cost savings. For this reason assumption 2 also applies to Rubinstein’s (1982) bargaining scheme under complete information.
Assumption 2 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 and Myerson 1982; Sappington 1982; Guesnerie and Laffont 1984) as well as the right level of effort (Laffont and Tirole 1986). If we add an (unobservable) first-period choice of investment in these models, proposition 1 below applies. Regulation under asymmetric information is a special instance of a mechanism design. Assumption 2 and proposition 1 would apply equally to the case of workers investing in skills and facing an income tax that is not contingent on their skill level and to that of consumers of a good produced by a monopolist, who invest in a consumption-related activity in an unobservable way.

Let us now derive the implication of assumption 2 for investment. 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 $\bar{e}_1, \ldots$”).

**PROPOSITION 1.** Under assumptions 1 and 2, the firm invests too little in the relationship $\bar{e}_1 \leq e^\ast$, where $e^\ast$ is the first-best level.

**Proof.** In the first period, the firm maximizes

$$\max_{e_1} (-e_1 + \gamma E\{\Phi_2[\hat{C}_2(e_1), \bar{e}_1]\}).$$

The first-order condition is

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

Assumption 2 then implies that

$$-1 - \gamma E\left[\text{pr}[\hat{V}_2 \geq \hat{C}_2(e_1)] \cdot \frac{\partial \hat{C}_2}{\partial e_1}\right] \geq 0$$

or

$$-1 - \gamma \int_{[\hat{V}_2 \geq \hat{C}_2(e_1)]} \frac{\partial \hat{C}_2}{\partial e_1} \geq 0.$$

Assumption 1 then implies that $\bar{e}_1 \leq e^\ast$. Q.E.D.

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8 Baron and Besanko (1984) and Laffont and 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.
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). He has forcefully argued that "opportunism" (i.e., renegotiation) is a threat to the accumulation of specific assets (see also Klein, Crawford, and Alchian 1978). Underinvestment results have also been found in Grossman and Hart's (1984, sec. 3) and Grout's (1984) models of bargaining under symmetric information. Proposition 1 and the discussion of assumption 2 show that Williamson's result has considerable generality (in terms of bargaining schemes and ex post information) when investment is not observable.

V. Observable Investment

Let us now assess the effect of the unobservability of investment. To this purpose assume first 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 level; if bankruptcy is an issue in the second period, bargaining will be affected.)

I stick to the assumption that various transaction costs preclude the use of full commitment and require renegotiation: when signing a contract, the two parties can agree on only 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

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9 In these two models, investment is unobservable or at least cannot be contracted on. The second-period information is symmetric but not observable by a third party. Furthermore, ex post messages are ruled out. Grout uses the generalized Nash bargaining solution. In Grossman and Hart bargaining consists in a take-it-or-leave-it offer about quality, the price having been determined ex ante.
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 bargain-
ing outcome for given value and cost levels.

Before making an assumption that allows comparison, let us add
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, I confine myself to point distributions for
$e_1$—see proposition 2.) Similarly, $\Psi_2(c_2, e_1)$ denotes the sponsor’s ex-
pected profit (over all its potential values) when the firm has cost $c_2$
and the sponsor believes investment $e_1$ has been made. For simplicity I
restrict myself 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). I will say that there is more
agreement (trade) when the set of values and costs such that agree-
ment is reached becomes larger. I will say that the sponsor prefers low
costs if $M_2(c_2, e_1) > \Psi_2(c_2', e_1)$ for $c_2 < c_2'$.

**Assumption 3.** (a) The sponsor prefers low costs. (b) 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 con-
stant).

To give an example of a bargaining process that satisfies assump-
tion 3, suppose that the firm makes a take-it-or-leave-it offer. Assump-
tion 3b is trivially satisfied since 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. Assumption 3a—
(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.

Assumption 3 implies the following proposition.

**Proposition 2.** Under assumption 3, $\tilde{e}_1 \succeq \tilde{e}_1$, where $\tilde{e}_1$ denotes an
optimal (mutually agreed-on) investment level under investment ob-
ervability, and $\tilde{e}_1$ denotes a pure strategy equilibrium investment
level under unobservability (if these exist; if either $\tilde{e}_1$ or $\tilde{e}_1$ is a random
variable, the same property holds for the upper and lower bounds of
their respective supports).

**Proof.** See Appendix A.

Proposition 2 gives a sufficient condition for investment to be
greater under observability. Assumption 3a, the basis for our intu-
tion, is fairly natural and is likely to be satisfied in most situations.
Assumption 3b, 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 assumption 3a). Imagine further that higher values
of $c_2$ signal lower values of $e_1$. In technical terms this can be expressed
PROCUREMENT AND RENEGOTIATION

by the assumption that the conditional cumulative distribution function \( F(c_2|e_1) \), with density \( f(c_2|e_1) \), has the decreasing hazard rate property \( (\partial/\partial e_1)[f(c_2|e_1)/F(c_2|e_1)] \leq 0 \). It is easily shown that the sponsor’s price \( p_s(v_2, e_1) \) decreases with the sponsor’s beliefs about \( e_1 \). 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 A presents such an example in which this “information effect” dominates the “externality effect” so that investment is lower under investment observability: \( e_1 < \bar{e}_1 \). So no general conclusion can be drawn at this stage about the relative sizes of investment under observability and nonobservability.

Note that if the assumption that \( c_2 \) and \( v_2 \) are private information is removed so that the two parties bargain under symmetric information, the information effect is eliminated and assumption 3b is satisfied: thus if the sponsor prefers low costs, \( \bar{e}_1 > e_1 \). Indeed, common bargaining processes are in general efficient under symmetric information, so that \( \tilde{e}_1 = e_1^* \), the first-best level.

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 A constructs an example in which the two parties overinvest relative to the first best: \( \bar{e}_1 > e_1^* \). 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.

Last, consider the case in which the first-period investment is observable but not verifiable. This means that the investment \( e_1 \) chosen by the firm can be observed by the sponsor but not by a third party (court) and, therefore, cannot be jointly determined. I compare the new investment level (\( \tilde{e}_1 \)) with 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 A, hence is not surprising.

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\[ \frac{\partial p}{\partial e} \propto \frac{(v_2 - p)}{(\partial f(p|e_1) / \partial e_1)} - \frac{\partial F(p|e_1)}{\partial e_1} \propto \frac{\partial f(p|e_1) / \partial e_1}{f(p|e_1)} - \frac{\partial F(p|e_1) / \partial e_1}{F(p|e_1)} \]

where \( \propto \) stands for “proportional to.”
Proposition 3. Assume that the investment is observable but not verifiable and that, for a given second-period cost, the firm prefers that the sponsor believe the investment was low; that is, \( \Phi_2(c_2, e_1) \) does not increase with \( e_1 \). Then the firm invests less than under investment unobservability: \( \tilde{e}_1 \leq \tilde{e}_1 \) (if the firm plays a mixed strategy under unobservability, then \( \tilde{e}_1 \leq \sup \tilde{e}_1 \)).

Proposition 3 applies, for instance, to the case in which the sponsor makes a take-it-or-leave-it offer and the cumulative distribution function of the firm’s cost has the decreasing hazard rate property (see above).

VI. Cancellation Fees

Now assume that a third party (court) can observe whether trade occurs and that the cost of doing so is sufficiently small that payments contingent on trade can be specified in the first-period contract. In this section I 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. 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 and 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 contracting impossible in general also work against a fair splitting of responsibility 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 Defense Department’s 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.

11 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 contract (see, e.g., Shavell 1980, 1984).
Consider the two-period model set up in Section II. Assume that the investment $e_1$ is not observed by the sponsor and that a cancellation fee $K \geq 0$ has to be paid by the sponsor to the firm in case of no trade. For simplicity, I assume that bargaining involves no delay (e.g., 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, that is, bonds that are posted by the firm and given up in case of nondelivery, 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 a fictitious value $(v_2 + K)$ (cost $[c_2 + K]$). This bargaining is in general equivalent to that between a sponsor with value $v_2$ and a firm with cost $c_2$ over a fictitious price $q = p - K$. The probability of agreement (trade) is the same as for $K = 0$; 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. I do not develop this point further as it will result from the analysis of a special case in the two examples below.

I now want to show that a cancellation fee can decrease investment. To this purpose, (a) I assume that the firm is risk averse, and (b) I 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 and $U_1$ and $U_2$ are concave. Also for simplicity I assume that the sponsor and the firm know, respectively, the value and the cost 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 (exhibits constant absolute risk aversion), its first-period investment is independent of (decreases with) the cancellation fee.

*Proof.* See Appendix B.

I have already given 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 a 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 is 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 $\Theta_2$ is uniformly distributed and $h$ is decreasing, a strictly risk-averse firm invests strictly less when the cancellation fee increases (see App. B).

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 and makes the sponsor more conciliatory. Second, it reduces the 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 (1983, p. 527), who notices that “a king who is known to cherish two daughters equally and is asked, for screening purposes, to post a hostage is better advised to offer the ugly one.” Such contracts, however, are rarely observed, as there is an ex post common incentive to disguise cancellation (or sign a new contract) 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 (1983) 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. In Section IV, as 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 equal to the specific investment and loses it to the firm if the firm has actually made the investment and the project is canceled. So if the specific investment is made, the firm’s second-period income is raised by the amount of the bond, that is, 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 since 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 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 a 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 my model the hostage technology is a roundabout way to do so. Here under investment observability, the main issue may not be the financing of the investment cost but the determination of its level (see Sec. V).

VII. Price Fixing and Cost Overruns

A. Fixed Payment

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 I 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 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 (e.g., 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 and Hart (1984) and Hall and Lazear (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 a fixed payment 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 VI, 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, need not make the first contract vacuous. Hart and Moore (1985) design a contract and a renegotiation process such that the initial price does
put a constraint on the renegotiation without imposing too much inflexibility the way the completely fixed price contract does. In their model, the initial contract does more than redistribute 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 setups are intermediate between—and often more realistic than—the polar cases of a completely fixed price (Grossman and Hart 1984) and unconstrained bargaining (Secs. IV and V 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 (1962, pp. 412, 429) estimated that for U.S. defense programs development costs exceed original predictions by 220 percent on average; in some cases costs have exceeded original predictions by as much as 14 times. (Some of the upward bias may simply come from statistical procedures; see Quirk and Teresawa 1984.) More recent estimates in different countries as well as the recent political debate in the United States 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” because of 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 unforeseen cost overruns” is the meaning of original cost estimates, that is, 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 1, when the contract is signed, only one
design, $q_0$, is known to all the parties (including the court) and can be contracted for. Design $q_0$ 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, $p_1 - p_0 = (q_1 - q_0)/2$. In this interpretation, technological improvements that cannot be described in the original contract lead to cost overruns.

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 of 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-on price $p_0$; assume for simplicity that the firm’s revealed second-period cost $c_2$ is observed by the sponsor. In bad states of nature ($c_2 > p_0$), 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 ($c_2 \leq p_0$) 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. I 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’ (Délegation Générale à l’Armement in France or Department of Defense in the United States) 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 and 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 unforeseen (except officially) by higher headquarters or the Congress. One may think of the government agency and the Congress as playing a revelation game with nonidentical preferences (in the style of Green and Stokey [1980] and Crawford and Sobel [1982]). Such a game typically has many equilibria, some of which give rise to phenomena resembling grade (or letters of recommendation) inflation.

Appendix A

Proof of Proposition 2

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

\[
E\{\gamma \Phi_2[\tilde{C}_2(\tilde{e}_1), \tilde{e}_1]\} - \tilde{e}_1 \geq E\{\gamma \Phi_2[\hat{C}_2(\hat{e}_1), \hat{e}_1]\} - \hat{e}_1, \tag{A1}
\]

\[
E\{\gamma \Phi_2[\hat{C}_2(\hat{e}_1), \hat{e}_1]\} + \gamma \psi_2[\tilde{C}_2(\tilde{e}_1), \tilde{e}_1]\} - \tilde{e}_1 \geq E\{\gamma \Phi_2[\hat{C}_2(\hat{e}_1), \hat{e}_1]\} + \gamma \psi_2[\tilde{C}_2(\tilde{e}_1), \tilde{e}_1]\} - \hat{e}_1. \tag{A2}
\]

Equation (A1) takes into account the fact that under nonobservability the firm can influence its cost distribution but not the sponsor’s beliefs about it (which are derived from the equilibrium investment \( \tilde{e}_1 \)). Adding (A1) and (A2) and using assumption 3a gives

\[
E\{\Phi_2[\hat{C}_2(\hat{e}_1), \hat{e}_1]\} + \psi_2[\tilde{C}_2(\tilde{e}_1), \tilde{e}_1]\} > E\{\Phi_2[\hat{C}_2(\hat{e}_1), \hat{e}_1]\} + \psi_2[\tilde{C}_2(\tilde{e}_1), \tilde{e}_1]\}. \tag{A3}
\]

Note that in (A3) the only difference between the left-hand side and the right-hand side is the sponsor’s beliefs about the firm’s investment. Also

\[
\Phi_2(c_2, e_1) + \psi_2(c_2, e_1) = E_{v_2}(v_2 - c_2)1_{\delta(v_2, c_2|e_1) = A}, \tag{A4}
\]

where \( 1_{\delta(v_2, c_2|e_1) = A} \) is equal to one when there is agreement and to zero in case of disagreement. Assumption 3b can be written

\[
\delta(v_2, c_2|e_1) = A \rightarrow \delta(v_2, c_2|\tilde{e}_1) = A. \tag{A5}
\]

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, \( c_2 \) or \( \tilde{c}_2 \) with \( c_2 < \tilde{c}_2 < v_2 \). There are two investment technologies. The cheap one does not involve any first-period expense and leads to cost \( c_2 \). The expensive one costs \( e_1 > 0 \) and leads to cost \( \tilde{c}_2 \) with probability \( \alpha \) and to cost \( \hat{c}_2 \) with probability \( (1 - \alpha) \). There is no discounting. Let us assume that

\[
v_2 - \tilde{c}_2 \leq \alpha(v_2 - \tilde{c}_2), \tag{A4}
\]

\[
v_2 - \hat{c}_2 \geq \alpha(v_2 - \tilde{c}_2) - e_1. \tag{A5}
\]
Inequality (A4) says that, if the sponsor knows that the firm has chosen the expensive technology, it plays “tough” (offers \( \xi_2 \)). Inequality (A5) then implies that, under investment observability, the optimal level of investment is \( \tilde{\epsilon}_1 = 0 \) (cheap technology).

Next assume that

\[ \alpha(\bar{\epsilon}_2 - \xi_2) > \epsilon_1 \]  

and define \( x \) and \( y \) by \( \nu_2 - \xi_2 = \alpha(\nu_2 - \xi_2) \) and \( \alpha(\bar{\epsilon}_2 - \xi_2) = \epsilon_1; x \) 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 (\( \bar{\epsilon}_1 = \epsilon_1 \)) with probability \( x \) and the cheap one (\( \bar{\epsilon}_1 = 0 \)) with probability \((1 - x)\). The sponsor charges \( \bar{\epsilon}_2 \) with probability \( y \) and \( \xi_2 \) with probability \((1 - y)\).

Last, to check that conditions (A4), (A5), and (A6) are not inconsistent, take \( \{\nu_2 = 4; \bar{\epsilon}_2 = 3; \xi_2 = 1; \alpha = \frac{1}{2}; \epsilon_1 = .75\} \).

Example in Which the Investment under Observability Exceeds the First-best Level

The sponsor’s value can be either \( \nu_2 \) or \( \bar{\nu}_2 \) \((\nu_2 < \bar{\nu}_2)\) with equal probabilities. The investment technology is deterministic. There are two levels of cost \( \xi_2 \), \( \bar{\epsilon}_2 \) \((< \nu_2 < \bar{\nu}_2)\). The investment cost for \( \xi_2 \) \((\bar{\epsilon}_2)\) is \( f_1 \) \((f_1)\): \( \epsilon_1 > f_1 \). Assume that

\[ \nu_2 - \xi_2 > \frac{1}{2}(\nu_2 - \xi_2), \]  

\[ \frac{1}{2}(\bar{\nu}_2 - \xi_2) > \nu_2 - \xi_2, \]  

\[ \epsilon_1 + \xi_2 = f_1 + \bar{\epsilon}_2 + \epsilon < \nu_2, \]  

where \( \epsilon > 0 \) is “small.”

Equation (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 \( \nu_2 \) if its cost is \( \xi_2 \), so there is the optimal level of implementation. If its cost is \( \bar{\epsilon}_2 \), it makes offer \( \bar{\nu}_2 \) \((\text{from } [A8])\) and there is suboptimal implementation. To determine \( \tilde{\epsilon}_1 \), we have to compare social welfare for the two possible investments:

- Investment \( e_1 \): \( \frac{1}{2}(\bar{\nu}_2 + \nu_2) - (\xi_2 + \epsilon_1) = A \),
- Investment \( f_1 \): \( \frac{1}{2}\bar{\nu}_2 - \frac{1}{2}\bar{\epsilon}_2 - f_1 = B \).

Clearly \( A - B > 0 \). So the second-best investment under observability may exceed 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 \( \tilde{\epsilon}_1 \) and \( \bar{\epsilon}_1 \), we have

\[ E\{\Phi_2[\hat{\xi}_2(\tilde{\epsilon}_1), \hat{\xi}_1]\} - \tilde{\epsilon}_1 \geq E\{\Phi_2[\hat{\xi}_2(\tilde{\epsilon}_1), \hat{\epsilon}_1]\} - \tilde{\epsilon}_1 \]

and

\[ E\{\Phi_2[\hat{\xi}_2(\bar{\epsilon}_1), \hat{\epsilon}_1]\} - \bar{\epsilon}_1 \geq E\{\Phi_2[\hat{\xi}_2(\bar{\epsilon}_1), \hat{\epsilon}_1]\} - \bar{\epsilon}_1. \]

\(^{12}\) For example, \( \{\xi_2 = 1; \bar{\epsilon}_2 = 2; \nu_2 = 3; \bar{\nu}_2 = 4.5; \epsilon_1 = 1.1; f_1 = 0\}.\)
Adding these two equations and using the assumption that $\Phi_2$ is nonincreasing 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 $\sup \bar{e}_1 \geq e_1$. Q.E.D.

Appendix B

Example 1: Proof of Proposition 4

Let $G(v_2)$ ($g(v_2)$) denote the cumulative distribution function (density) of the sponsor’s value in period 2.

If the firm makes an offer $p$, the sponsor accepts 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 $q = p - K$ and optimizing over $q$ gives the first-order condition

$$-g(q)[U_2(q + K - c_2) - U_2(K)] + [1 - G(q)]U_2(q + K - c_2) = 0.$$ 

(B1)

I will assume that the second-order condition is satisfied; a sufficient condition for this is that the density $g$ is nondecreasing everywhere. Let $q^*(c_2, K)$ denote the optimum and let $p^*(c_2, K) = q^*(c_2, K) + K$. Equation (B1) 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 $\{1 - G(q^*(c_2, K))\}$.

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

$$\frac{\partial q^*}{\partial K} \propto \frac{U'(K)}{U(q^* + K - c_2) - U(K)} - \frac{U''(q^* + K - c_2)}{U'(q^* + K - c_2)},$$ 

(B2)

and $p^*$ is easily shown to grow with $K$. Thus the sign of $\partial q^*/\partial K$ is a priori ambiguous. In particular, if $\partial q^*/\partial K > 0$, 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

$$-U'_1(-e_1) - \gamma E\left\{1 - G[q^*(c_2, K)]\right\}U'_2[q^*(c_2, K) + K - c_2] \frac{\partial C_2}{\partial e_1} = 0.$$ 

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

$$\frac{\partial e_1}{\partial K} \propto \gamma E\left\{g(q^*) \frac{\partial q^*}{\partial K} U'_2 \frac{\partial C_2}{\partial e_1} - [1 - G(q^*)]U'_2 \frac{\partial p^*}{\partial K} \frac{\partial C_2}{\partial e_1}\right\}.$$ 

(B3)

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 (B3). The first term corresponds to the change in trade. If the cancellation fee reduces implementation ($\partial q^*/\partial K > 0$), it also tends to reduce investment (as $\partial C_2/\partial e_1 < 0$). The second term unambiguously leads to less investment (as $\partial p^*/\partial K > 0$, $\partial C_2/\partial e_1 < 0$, $U''_2 < 0$). The point is that a cancellation fee increases the price. Therefore it decreases the marginal util-
ity 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 $U_2$: $U_2(x) = -e^{-\theta x} (\theta > 0)$. Equation (B2) implies that $q^*/K = 0$, so that implementation does not depend on the cancellation fee. The analysis of (B3) then implies that $de_1/K < 0$. Q.E.D.

The Sponsor Makes a Take-It-or-Leave-It Offer

Let $F (f)$ be the cumulative distribution (density) of the firm's cost conditional on the firm's making its first-period equilibrium investment $\bar{e}_1$. A risk-neutral sponsor chooses $q = p - K$ so as to maximize $\left\{1 - F(q)\right\}(-K) + F(q)(\nu_2 - q - K)$. The optimal $q^*(\nu_2, K, \bar{e}_1)$ 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

$$-U'(\bar{e}_1) - J_{[q^*(\nu_2, e_1) > c_2]} U_2(q^*(\nu_2, \bar{e}_1) + K - c_2) \frac{\partial C_2}{\partial e_1} = 0. \quad (B4)$$

Note that in a rational expectations equilibrium $e_1 = \bar{e}_1$. If $\bar{C}_2 = \Theta_2 h(e_1)$, where $h$ is decreasing and convex and $\Theta_2$ is uniformly distributed, then the total derivative of (B4) 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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