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Holdups, simple contracts and information acquisition

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Abstract

In a typical procurement setup, several recent papers have shown that when complete contracting is not possible, simple, noncontingent contracts may suffice to solve the under-investment problem. This paper points out that a noncontingent contract offer such as a fixed-price contract may induce the seller to acquire information on the future course of costs and only to accept the offer if the cost is low. It is shown that sometimes the buyer prefers to wait and buy on the spot market than to offer a long-term contract. When the seller rejects a contract offer or the buyer chooses not to make one, the seller will not make efficient investments because he expects to be held up on the spot market.
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1. Introduction

It is now well known that when relationship-specific investments are involved that affect future outcomes in a procurement relationship, a long-term contract between the buyer and the seller is often necessary to provide investment incentives. Contracts, however, are often necessarily incomplete because some of the relevant economic variables or the states of nature may not be verifiable to a third party (Hart and Holmström, 1987). This observation leads to new interpretations of economic institutions, such as the firm and corporate financial structure, as remedies for incompleteness of contracts (Williamson, 1985; Grossman and Hart, 1986; Hart and Moore, 1990; Aghion and Bolton, 1992).

Recently, several authors (Aghion et al., 1990; Chung, 1991; Hermalin and Katz, 1993; Nöldeke and Schmidt, 1995; Edlin and Reichelstein, 1996) have shown that contractual

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incompleteness does not necessarily lead to inefficient under-investments. In fact, the above authors show that the first-best outcome can be obtained by appropriately-designed simple, noncontingent contracts. Although such contracts may not be ex post efficient and are often subject to future renegotiation, the initial agreement can affect the status quo of the future bargaining and hence can be used to mitigate opportunistic behavior that may arise in the absence of an ex ante agreement.

A simple, noncontingent contract such as a fixed-price contract, however, is not without its problem. As Goldberg and Erickson (1987) noted, a fixed-price contract may induce wasteful precontractual information acquisition. In their study of petroleum coke contracts, Goldberg and Erickson argue that an important reason to include price adjustment mechanisms in long-term contracts is to reduce precontractual oversearch of information (see also Goldberg, 1985).

In a simple procurement situation, for example, after the buyer offers a fixed-price contract, the seller has incentives to expend resources to improve his information on the future course of costs. By doing so, the seller is able to refuse the contract in unfavorable states and hence avoid a potential loss but accept it in favorable states and hence reap a surplus. Anticipating this, sometimes the buyer may prefer to wait and buy on the spot market than to offer a long-term contract. Whenever the seller rejects a contract offer or the buyer chooses not to make one, the seller will not make an efficient investment because he expects to be held up on the spot market. This result, therefore, calls into question the efficiency result obtained by the papers cited above and restores hold-ups as a serious problem in inter-firm relationships. It also gives an explanation for the shortage of beneficial long-term contracts in the real world.

As an example, consider a typical holdup situation (Klein et al., 1978; Williamson, 1985). A rare and precious mineral source is discovered in a remote town. Suppose the town owns the source and needs a company to mine the mineral. After acquiring some general knowledge about the mining business, the town knows that the mineral is worth 25 million dollars and the cost of mining depends both on some unknown states of nature (e.g., the particular characteristics of the mine and the mineral or the possible change in the costs of mining equipment) and on whether a general (i.e., redeployable) or a specific investment in physical assets will be made. For a general investment, the expense of which is normalized to 0, the cost of mining can be either 20 million dollars or 10 million dollars with equal possibility. But for a specific investment, the expense of which is 3 million dollars, the mining cost can be either 15 million dollars or 5 million dollars. As is normally assumed in the literature, the mining company has no superior knowledge about the cost structure, which, however, will be realized and observed by both parties at the beginning of mining.

In general, waiting until the mining work begins to sign a spot contract will not induce the company to invest in specific physical assets, because ex post bargaining may give the company a share of surplus that is too small to provide it with sufficient ex ante incentives to make specific investments. Suppose that the town, which has the monopoly rights to the mineral, has all the bargaining power in negotiating a deal with the mining company. A completely state-contingent, long-term contract between the two parties will induce the company to make the efficient specific investment, regardless of the ex ante distribution of information about the future state of nature. Even if the investment and the states of

nature are not contractible ex ante because they cannot be verified, a simple, noncontingent long-term contract (e.g., an offer of 13 million dollars by the town) may still lead to efficient investments, as long as both parties have symmetric information ex ante. This efficiency result may be untenable, however, if we allow the parties to acquire information before signing a noncontingent contract.

Suppose that the town has no ability to acquire further information ex ante, but the mining company may, before accepting the offer, incur a cost to learn about the future state of nature. This is plausible because, although the firm may only have as much general prior knowledge about the mining business as the town people, it may possess superior ability to undertake further investigation for the fact that the firm may have been in the mining industry for a long time. Now suppose the town offers 13 million dollars for the job regardless of the future cost. If the information cost is small enough, the company would have incentives to conduct research that will reveal to them what the cost of mining will be. The firm then accepts the offer if it finds the state of nature to be favorable, but rejects the contract otherwise. By doing so, the firm can make an expected profit of 2.5 million dollars minus the information cost. Two sources of inefficiency will arise as a result of information acquisition. First, the information cost is socially wasteful. Second, the firm, after rejecting the contract in the high-cost state, will not make efficient specific investments.

Another possibility is that the buyer offers a contract that is attractive enough (e.g., an offer of 18 million dollars) so that the mining company would accept the offer without acquiring further information. The problem is that the buyer may not be willing to do so. This is because the buyer has the option to wait until the mining begins when the state of nature is realized and sign a spot contract with the firm. The town's expected payment to the firm will be only 15 million dollars. Without an ex ante commitment from the town, the firm would only make a general investment.

Note, however, that information acquisition is worthwhile for the firm only if the initial agreement is a simple fixed-price contract. If a completely contingent contract is possible, there will be no benefit for the firm to acquire any information. In this event, the town can make an offer that pays the firm the actual cost of mining plus the ex ante specific investment expense for each possible state of nature. The firm should accept the contract and make the optimal investment decision.

For related literature, Barzel (1982) and Kenney and Klein (1983) study wasteful information oversearching and its implications for real world pricing practices. Craswell (1988) studies a situation in which precontractual information acquisition is productive because it reduces the probability of contract breach.

This paper is most closely related to Crémer and Khalil (1992). In that paper, the authors study the effect of information acquisition on the terms of contracts in a one-period principal-agent model and demonstrate the difference between asymmetry in abilities to acquire information and asymmetry in information. In their model, after being offered a contract but before deciding whether to accept, the agent can, at a cost, acquire information about the state of nature, which he will eventually observe ex post even without acquiring information. However, the principal cannot observe the state of nature at anytime. They show that to any contract that induces observation there corresponds a (weakly) dominating one that does not induce observation. Nevertheless, the presence of the possibility of acquiring information will substantially change the terms of trade

even if in equilibrium the seller does not acquire information. This paper shares their insights on the implication of information acquisition but studies how the possibility of acquiring information before signing a long-term contract can lead to under-investment and the inefficient use of spot contracts in the hold-up problem when contracts have to be simple. Crémer and Khalil (1994) and Crémer et al. (1998) study a variation of the above model in which the seller can acquire information before the contract is offered.

Other related papers include Crawford (1988), Fudenberg et al. (1990), and Rey and Salanié (1992). They identify sufficient conditions for a sequence of short-term contracts to be equivalent to the efficient long-term contract in various contexts.

The rest of the paper is organized as follows. Section 2 lays out the basic model. Section 3 characterizes the equilibrium outcomes. Section 4 concludes the paper.

2. The model

The model has two periods. A risk-neutral buyer (hereafter referred to as 'she') needs one unit of an indivisible good that can be produced by a risk-neutral seller (hereafter referred to as 'he').[1] The buyer's valuation of the good is a constant V. In the first period, the seller can make a relationship-specific investment that costs I.[2] Production (if any) takes place in the second period. The production cost is a function of investment and the state of nature ω, denoted as $C(K, \omega)$, where $K \epsilon \{0, I\}$ and $\omega \epsilon \{\omega_l, \omega_h\}$.[3] At the beginning of period one, both parties are uncertain but have a common belief about ω. Let $\pi_l \in (0, 1)$ denote the probability of ω_l and $\pi_h = 1 - \pi_l$ the probability of ω_h. However, the state of nature will be realized and observed by both parties at the beginning of period two.

To simplify the notation, define $\alpha_i = C(0, \omega_i)$ and $\beta_i = C(I, \omega_i) + I$ where $i \epsilon \{l, h\}$. Suppose $\beta_h > \beta_l$, and $\alpha_h > \alpha_l$. Throughout the paper, it is assumed that $\beta_i < \alpha_i$ for $i \in \{l, h\}$. In addition, we assume $V > \alpha_h$. In other words, a specific investment is socially desirable in any state, as is production regardless of whether investment is made or not, implying that information acquisition has no social value. This is called the 'gap' case in the bargaining literature (Fudenberg and Tirole, 1991, p. 408). This assumption precludes ex post mutually beneficial renegotiation and allows us to focus on the inefficient aspect of information acquisition. We make the model as simple as possible so that a fixed-price contract can achieve the first best in the absence of information acquisition and, then, show

[1] Variable quantities or explicit randomization are needed for the first-best outcome in Aghion et al. (1994), Chung (1991) and Edlin and Reichelstein (1996).

[2] Most models in the related literature study the case in which both parties make variable relationship-specific investments, and both the value and the cost of the good are state-dependent. We assume a fixed investment level so that over-investment will not arise in our model in contrast to, for example, Edlin and Reichelstein. Our result is not weakened by the simplification because we are stacking the deck in favor of the first-best outcome in the absence of information acquisition.

[3] To simplify the analysis, we focus on the two-state case. Most of our qualitative results should hold when there are more than two states.

how introducing the possibility of acquiring information by the seller before signing a contract may overturn the efficiency result. [4]

For simplicity and in line with most models in the contracting literature, assume that the buyer has all the bargaining power and can make a take-it-or-leave-it offer to the seller. It is approximately the case when there are a few other potential suppliers. The state of nature, the production cost of the good, and the investment decision are assumed to be ex post observable but not contractible. [5] This rules out the possibility of a contingent contract. In addition, we assume that the seller's act of information acquisition is either unobservable or noncontractible.

At the beginning of period one, the buyer can offer a simple fixed-price contract that calls for the seller to deliver a unit of the good in the second period and for the buyer to pay the seller a price p upon the delivery of the good. [6] However, as we argued in the introduction, a noncontingent contract may induce the seller to acquire information about the future state of nature. We assume, and it is the distinguishing feature of the model, that, in the first period, i.e., before the state of nature is realized, the seller can incur a cost z to acquire information and observe ω, while the buyer has no such ability. [7]

Because information acquisition is costly, the seller, after being offered a contract, can choose to accept it or reject it without acquiring any further information or to acquire

[4] The analysis will not change qualitatively in the 'no-gap' case as long as pre-contractual information acquisition has no social value in the sense that $z > \pi_h I$. In the 'no-gap' case, $\beta_h > V_h$, and investments in the high-cost state are wasteful. Therefore, when $z \leq \pi_h I$, it is efficient to have information acquired before investments are made. Craswell (1988) and Lewis and Sappington (1997) study the case in which pre-contractual information acquisition is productive.

[5] It may be so either because they are not verifiable to the court or because they are too complicated to be written precisely (see Grossman and Hart (1986) for more justifications). This is a standard assumption in the incomplete contracts literature, which focuses on the effect of ex ante contracts on ex post bargaining that, in turn, affects ex ante investments. Ex post observability implies ex post perfect and symmetric information. Therefore, the bargaining game in the second period is easier to solve. In contrast, Crémer and Khalil (1992) study a principal-agent model in which there is ex post information asymmetry.

[6] Hart and Moore (1988) assume that the court can only observe whether the trade occurs or not; but when the trade does not occur, the court cannot observe whether it is because the seller did not deliver the good or because the buyer did not take the delivery. As shown by Nöldeke and Schmidt, it is this assumption that underlies the inefficient outcome in Hart and Moore. Following the papers in which the first-best outcome is obtained by simple contracts, we assume that the court can verify who is responsible for a no-trade outcome. Some authors have considered more complicated contracts such as option-to-sell contracts in Nöldeke and Schmidt and fill-in-the-price contracts in Hermalin and Katz. To the extent that these more complicated contracts are not fully contingent, the seller may still have incentives to acquire information.

[7] If the seller just learns the state of nature more precisely but not perfectly, the analysis becomes much more complicated. The qualitative result, however, should still hold. For example, suppose initially both parties believe that both states are equally possible; but the seller, after acquiring further information, learns which state is less likely to occur (say, at the probability of 1/4). We further suppose that it is equally possible that either the high-cost state or the low-cost state is less likely to occur. Suppose the production cost is either \$20 or \$10 without investment, and it is either \$15 or \$5 with a \$4 investment. It can be verified that a price offer of \$15 will induce information acquisition when information cost is \$0.5. An offer at, for example, \$16 will be accepted; but it is higher than the expected payment of \$15 that the buyer would make if she just waits until the second period and signs a spot contract.

information at a cost z before making any decision.[8] If the seller accepts the contract, it will be executed in the second period. This is because, with the assumption that $V > \alpha_h$, there will not be any mutually beneficial renegotiation.[9] If the seller rejects the contract, they proceed to the second period.[10] After the buyer's offer is accepted or rejected, the seller decides whether to invest in the first period or not. If the initial contract is rejected in the first period, the buyer can, in the second period, offer the seller another take-it-or-leave-it contract after the state of nature is realized.[11] If this second contract is accepted, it will be executed at the end of period two. If it is rejected, the game ends. The game can be summarized in the following time line.

3. Characterization of equilibrium contracts

We have structured the model such that if an ex ante contract is accepted, the seller should invest because in any state the total cost (production plus investment) is lower if he invests I, namely, $\beta_i < \alpha_i$ for $i = l, h$. On the other hand, the seller would not make the investment if he rejects the initial contract. This is because, after the state is realized, the buyer would offer a procurement price that would merely cover the production cost and drive the seller's surplus to zero, which is assumed to be his normalized reservation

[8] Here we assume that there is enough time for the seller to acquire information before signing the contract if he decides to do so. In other words, the buyer, after offering a contract, must allow some time for the seller to study the contract and make it clear what are the possible scenarios and what the cost will be under each scenario. This thinking process may take some time but is not very costly. During this time period, the seller has the option to incur a cost to acquire information about the future state of nature. Of course, the cost of information is normally dependent on the time allowed for the activity; and when information acquisition is not desirable from the buyer's point of view, she will allow only the shortest time necessary for the seller's first task. For simplicity, we assume away this dependence of information cost on time allowed for gathering information. Even if the buyer can make an exploding offer, the seller can gather information before the offer is made instead of before signing the contract (see Crémer and Khalil, 1994). Our qualitative results should still hold.

[9] When the cost of production turns out to be higher than the price, the seller might want to breach the contract. But as long as the court imposes standard breach remedies, e.g., expectation damages or specific performance, the seller will do no better than not to breach the contract. It should be noted, however, that a breach remedy of expectation damages may be inconsistent with our assumption on the unverifiability of the state of nature.

[10] For simplicity, we ignore the possibility of further bargaining because it would not qualitatively change our main results. Even if we allow further bargaining, there is generally a positive probability that the parties cannot agree on a contract because, after the seller's rejection of the initial contract, there is asymmetry in information regarding whether the seller has acquired information and, if he has, whether the state of nature is a high-cost one or a low-cost one.

[11] This is likely the case when the buyer can negotiate with other potential sellers. If the seller makes investments without accepting a long-term contract first, he may have some bargaining power because he now has a cost advantage over other potential sellers. For ease of exposition, we assume that the buyer deals with the same seller and has all the bargaining power in both periods. What is actually needed for our analysis is that the seller does not have enough bargaining power such that he will receive a sufficient share of surplus from investment in ex post bargaining. If the seller has enough bargaining power, the hold-up problem will disappear. The whole point hinges upon the assumption that the seller's bargaining power is not strong enough to prevent holdups. We assume that there is no credible way to decide ex ante on the ex post allocation of bargaining power. But even if the parties can contractually allocate all the ex post bargaining power to the seller (see Aghion et al., 1994 and Chung, 1991), they may still not be able to agree on how much the seller should pay for this favor. This is because the value of this bargaining power allocation to the seller depends on the future state of nature, and given an offer from the buyer, the seller may still have incentives to acquire information.

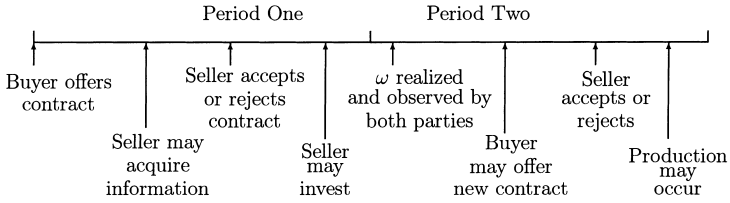

Fig. 1. Timing of events.

utility level for participation. Anticipating this, the seller should not invest in the first period (Fig. 1).

In period one, the buyer announces a price p, to which the seller responds by choosing either to accept the contract without acquiring information, or to reject the contract, or to acquire information and then decide whether to accept or reject the contract. We employ subgame-perfect equilibrium as the solution concept to the contracting game. To ease the exposition, we define

$$\alpha^{\mathrm{e}} \equiv \pi_l \alpha_l + \pi_h \alpha_h \tag{1}$$

which is the expected production cost if the seller does not make the investment, and

$$\beta^{\mathrm{e}} \equiv \pi_l \beta_l + \pi_h \beta_h, \tag{2}$$

which is the expected production cost plus the investment expense if the seller does invest.

Clearly, when information acquisition is not possible, the buyer will offer a contract in which $p = \beta^{\mathrm{e}}$, and the seller will accept the offer and make an efficient investment. This result should also be true when the cost of acquiring information is sufficiently high. To show this, suppose the seller acquires information. His expected payoff is then $\pi_l(p - \beta_l) - z = \pi_l(\beta^{\mathrm{e}} - \beta_l) - z$, because the seller will accept p when the state is ω_l and reject p when the state is ω_h. Therefore, when

$$z \geq \hat{z} \equiv \pi_l(\beta^{\mathrm{e}} - \beta_l), \tag{3}$$

i.e., when the information cost is greater than or equal to the expected gains from the information, the seller has no incentives to acquire information but to accept the contract offer. We restate this result in the following proposition.

Proposition 1. *If $z \geq \hat{z} \equiv \pi_l(\beta^{\mathrm{e}} - \beta_l)$, i.e., the cost of information acquisition is sufficiently high, then, in equilibrium, the buyer offers a fixed-price contract $p = \beta^{\mathrm{e}}$, and the seller accepts the contract and subsequently makes efficient investments.*

The fixed-price contract, however, may run into problems if the information cost is small (i.e., $z < \hat{z}$). It is because the seller now has incentives to acquire information and only accept the offer when the state of nature is favorable. The seller can reap a surplus $\hat{z} - z$. The buyer's expected payment for the good, therefore, would be $\pi_h \alpha_h + \pi_l \beta^{\mathrm{e}}$ rather than β^{e}. Inefficiencies result because no investment is made if the state of nature is a high cost one and the cost of information acquisition is wasted.

The buyer, of course, can offer a price that is high enough (say $p = \beta_h$) so that the seller would not have incentives to acquire further information but to accept the offer. In that case, the seller obtains a rent. The rent, however, may be so high that the buyer may prefer to wait until the second period and then sign a spot contract and forego the efficiency gains from investments. By doing so, the buyer's expected payment is α^e, which can be less than the amount she has to pay in order to induce the seller not to acquire information.

Whether a long-term contract will be signed (hence efficient investments will be made) should depend on both the cost of information acquisition and the efficiency gains from investments. One would expect that when information cost or/and efficiency gains are high, a long-term contract is more likely to be signed, and vice versa.

In the rest of the section, we assume

$$z < \hat{z}, \tag{4}$$

which says that the seller's cost of gathering information is less than his expected gains from the information in the case of a price offer $p = \beta^e$.

The payoff structure of the game depends on the buyer's contract offer and the seller's response and is summarized as follows.

- If the seller accepts the buyer's contract p without acquiring information
  $p - \beta^e$ for the seller,
  $V - p$ for the buyer.
- If the seller rejects the contract
  0 for the seller,
  $V - \alpha^e$ for the buyer.
- If the seller acquires information
  and $p < \beta_h$
    $\pi_l(p - \beta_l) - z$ for the seller,
    $V - (\pi_l p + \pi_h \alpha_h)$ for the buyer;
  and $p \geq \beta_h$
    $p - \beta^e - z$ for the seller,
    $V - p$ for the buyer.

The above payoff structure is self-evident. We first analyze the seller's optimal response to different price offers. From the payoff structure, it is apparent that if and only if $p - \beta^e \geq 0$ and $p - \beta^e \geq \pi_l(p - \beta_l) - z$, which, after re-arrangement, becomes

$$p \geq \beta_h - \frac{z}{\pi_h}, \tag{5}$$

the seller would accept the offer without acquiring information.[12] On the other hand, if and only if $p - \beta^e < 0$ and $\pi_l(p - \beta_l) - z < 0$, which, after re-arrangement, becomes

[12] When Eq. (5) holds with equality, the seller is indifferent between acquiring information and simply accepting the offer. We assume, throughout the paper, that, when indifferent, the seller acts in the manner that maximizes the total surplus. That is, when he is indifferent between accepting and rejecting a contract, he accepts it; and when he is indifferent between outright rejection and acquiring information, he chooses to acquire information first and then decides whether to accept or reject the contract.

$$p < \beta_l + \frac{z}{\pi_l}, \tag{6}$$

the seller would reject the contract.

Therefore, the seller would acquire information if and only if

$$\beta_h - \frac{z}{\pi_h} > p \geq \beta_l + \frac{z}{\pi_l}. \tag{7}$$

Note that under the assumption $z < \pi_l(\beta^e - \beta_l)$, we can verify that

$$\beta_h - \frac{z}{\pi_h} > \beta^e > \beta_l + \frac{z}{\pi_l}. \tag{8}$$

Next, we analyze the buyer's optimal strategy in anticipation of the seller's best response. It is clear that the buyer should choose either $p = \beta_h - z/\pi_h$, which will be accepted by the seller, or $p = \beta_l + z/\pi_l$, which will induce the seller to acquire information, or $p < \beta_l + z/\pi_l$, which will be rejected by the seller.[13] The buyer's expected payoff becomes

$V - \alpha^e$ if no offer is made or her offer is rejected (i.e., when $p < \beta_l + z/\pi_l$);

$V - (\pi_l\beta_l + \pi_h\alpha_h + z)$ if her offer leads to information acquisition (i.e., when $p = \beta_l + z/\pi_l$);

$V - (\beta_h - z/\pi_h)$ if her offer is accepted (i.e., when $p = \beta_h - z/\pi_h$).

The buyer chooses among the three strategies to maximize her expected payoff or equivalently, minimize her expected payment for the good. The following proposition follows naturally from comparing the expected payoff the buyer obtains from playing one strategy with those from playing the other two.

Proposition 2. *Suppose* $0 < z < \hat{z}$. (1) *If and only if* $\beta_h - z/\pi_h - \beta^e \leq \max\{\alpha^e - \beta^e, \pi_h(\alpha_h - \beta_h) + z\}$, *the buyer offers* $p = \beta_h - z/\pi_h$, *which the seller accepts without acquiring information and subsequently makes investments*; (2) *if and only if* $z \leq \pi_l(\alpha_l - \beta_l)$ *and* $\pi_h(\alpha_h - \beta_h) + z < \beta_h - z/\pi_h - \beta^e$, *the buyer offers* $p = \beta_l + z/\pi_l$, *and the seller acquires information and accepts the contract (and hence makes investments) only when* $\omega = \omega_l$; (3) *if and only if* $\alpha^e - \beta^e < \beta_h - z/\pi_h - \beta^e$ *and* $z > \pi_l(\alpha_l - \beta_l)$, *the buyer waits until the second period and signs a spot contract, and the seller makes no investment.*

The proposition can be understood by considering the trade-offs the buyer faces between the efficiency gains from investments and the rent required to induce straight acceptance and hence provide appropriate investment incentives under the threat of information acquisition.

In choosing between inducing acceptance and waiting to sign a spot contract, the buyer compares the surplus $\alpha^e - \beta^e$ — the expected gains from efficient investments — with the information rent she must give up, $\beta_h - z/\pi_h - \beta^e$. If $\alpha^e - \beta^e \geq \beta_h - z/\pi_h - \beta^e$, the buyer prefers offering an acceptable contract to not signing a contract, and vice versa.

In the case of information acquisition, the surplus is $\pi_l(\alpha_l - \beta_l) - z$ — the expected efficiency gains from investing in the low-cost state minus the information cost z. The seller receives no rent. Therefore, in choosing between inducing information acquisition and waiting, the buyer prefers the former if $\pi_l(\alpha_l - \beta_l) \geq z$, and vice versa.

[13] Any price less than $\beta_l + z/\pi_l$ yields the same outcome in equilibrium. Offering such prices is equivalent to not making any offer.

The difference between the surplus in the case of straight acceptance and that in the case of information acquisition is $\pi_h(\alpha_h - \beta_h) + z$ (where $\pi_h(\alpha_h - \beta_h)$ is the difference between the gains from efficient investments and the gains from investing only in the low-cost state). In choosing between inducing straight acceptance and inducing information acquisition, the buyer prefers the former if this difference in surpluses is at least as large as the information rent (i.e., $\pi_h(\alpha_h - \beta_h) + z \geq \beta_h - z/\pi_h - \beta^{\mathrm{e}}$), and vice versa.

To restate the proposition in plain English, (1) when efficiency gains from investments are high and/or information cost is high (hence the information rent is low), the buyer prefers to offer a contract that is attractive enough for the seller to accept; (2) when information cost is sufficiently low (hence the information rent is high) and/or the efficiency gains from investing in the low-cost state are high, but the gains from also investing in the high-cost state are low, the buyer prefers to induce the seller to acquire information; and (3) when gains from efficient investments are low and information cost is also low but not lower than the expected gains from investing only in the low-cost state, the buyer prefers to wait until the second period to sign a spot contract.

It is convenient to summarize the results of the paper in a table that shows which equilibrium could arise as a function of the values of the parameters. First, we define the following notations:

$$\begin{cases} z^* &= \pi_h(\beta_h - \pi_l\beta_l - \pi_h\alpha_h)/(1+\pi_h) \\ z^{\#} &= \pi_l(\alpha_l - \beta_l) \\ z^0 &= \pi_h(\beta_h - \alpha^{\mathrm{e}}). \end{cases}$$

It is easy to verify that Table 1 is derived from Propositions 1 and 2.

In line (1), when the information cost is sufficiently high, the first-best outcome can be achieved and the result is the same as if there were no possibility of acquiring information. In lines (2), (3a) and (4a), although the first-best outcome can be achieved, the buyer has to pay the seller an information rent even if in equilibrium the seller does not acquire any

Table 1
Summary of the results

Case	Parameters	Information cost (z)	Long-term contract?	Investment?	Price	Information acquired?
1	No restriction	$z \geq \hat{z}$	Yes	Yes	β^e	No
2	$\beta_h \leq \pi_l\beta_l + \pi_h\alpha_h$	$z < \hat{z}$	Yes	Yes	$\beta_h - z/\pi_h$	No
3a	$\beta_h > \pi_l\beta_l + \pi_h\alpha_h$, and $\beta^e < \pi_l\alpha_l + \pi_h\alpha^e$	$z^* \leq z < \hat{z}$	Yes	Yes	$\beta_h - z/\pi_h$	No
3b	$\beta_h > \pi_l\beta_l + \pi_h\alpha_h$, and $\beta^e < \pi_l\alpha_l + \pi_h\alpha^e$	$z < z^*$	Yes if $\omega = \omega_l$	Yes if $\omega = \omega_l$	$\beta_l + z/\pi_l$	Yes
			No if $\omega = \omega_h$	No if $\omega = \omega_h$		
4a	$\beta_h > \pi_l\beta_l + \pi_h\alpha_h$, and $\beta^e \geq \pi_l\alpha_l + \pi_h\alpha^e$	$z^0 \leq z < \hat{z}$	Yes	Yes	$\beta_h - z/\pi_h$	No
4b	$\beta_h > \pi_l\beta_l + \pi_h\alpha_h$, and $\beta^e \geq \pi_l\alpha_l + \pi_h\alpha^e$	$z^{\#} \leq z < z^0$	No	No	Nil	No
4c	$\beta_h > \pi_l\beta_l + \pi_h\alpha_h$, and $\beta^e \geq \pi_l\alpha_l + \pi_h\alpha^e$	$z \leq z^{\#}$	Yes if $\omega = \omega_l$	Yes if $\omega = \omega_l$	$\beta_l + z/\pi_l$	Yes
			No if $\omega = \omega_h$	No if $\omega = \omega_h$		

information. In lines (3b) and (4c), the seller will acquire costly information; if the state is unfavorable, he will reject the buyer's offer and make no investment. Two types of social losses may arise in these two cases: the cost of information acquisition, and the efficiency loss resulting from under-investment in the bad state. Finally, in line (4b), ex ante bargaining breaks down; and the buyer is willing to wait until the state of nature is realized and adopt a spot contract rather than offer an ex ante acceptable long-term contract.

4. Conclusion

This paper studies how in the hold-up problem the possibility of acquiring information before signing a long-term contract can significantly change the terms of the contract and efficiency in ex ante specific investments if only noncontingent contracts can be written. It is shown that the mere possibility of ex ante inefficient information acquisition may lead to the use of inefficient spot contracts and, consequently, result in under-investment in relationship-specific assets. Contrary to several recent papers, this result restores hold-ups as a serious problem in inter-firm relationships. Moreover, it gives an explanation for why we see a shortage of long-term contracts even in the absence of other possible imperfections such as ex ante information asymmetry, risk-aversion and limited liability.

With the results, we can contrast three types of information structure: (1) symmetric information with a possibility of ex ante inefficient information acquisition; (2) symmetric information with no such possibility; and (3) ex ante asymmetric information. It is demonstrated that the latter two are the polar cases of the former with high or low information cost, respectively. Efficiency can be achieved in the hold-up problem in case (2) even if contracts are incomplete; it can be achieved in case (1) if information cost is high or certain conditions are satisfied (e.g., the efficiency gains to investment are high); and it can also be achieved in case (3) if contracts can be completely contingent on the state of nature. Therefore, it is the three factors combined that drive our inefficiency result, namely, specific investments, contract incompleteness, and asymmetric ability to acquire information.

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