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ABSTRACT

Incomplete Contracts, the Hold-Up Problem and Asymmetric Information

Given symmetric information, in a standard hold-up problem a buyer's investment incentives are always increasing in his bargaining power. While this result is robust under one-sided private information, it can be overturned under two-sided private information.

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1 Introduction

The hold-up problem plays a central role in the recent literature on incomplete contracts and the modern theory of the firm.[1] Consider a buyer and a seller who can trade a good (or a service) at some future date 2. At date 1, the buyer can make a relationship-specific investment that increases his expected value from receiving the good. It is always ex post efficient to trade, but the terms of trade cannot be fixed ex ante. Hence, the parties bargain at date 2. As has recently been emphasized by Hart and Moore (2007),[2] the literature typically assumes that there is symmetric information, so that ex post efficiency will always be achieved. However, since in general the buyer gets only a fraction of the date-2 surplus, his incentives to invest are dulled. It is a standard result that the more bargaining power the buyer has at date 2, the more he will invest at date 1.

In this paper, the assumption that there is symmetric information will be relaxed. It is well known that under asymmetric information, bargaining might not lead to ex post efficiency.[3] However, as long as there is only one-sided private information (i.e., either only the seller or only the buyer has private information), it is still the case that the buyer's investment is increasing in his bargaining power. In contrast, if there is two-sided private information, then the standard result may be overturned. Provided that

[1]See Hart (1995) for a comprehensive textbook exposition and see Maskin and Tirole (1999) and Tirole (1999) for critical discussions of the incomplete contracting methodology. See also Schmitz (2001) for a literature survey.

[2]See also the critical discussions of this point in Holmström (1999) and Williamson (2002).

[3]On bargaining theory, see Muthoo (1999) and the literature discussed there.

the marginal costs of investment are sufficiently large, it turns out that the buyer's investment level can be *decreasing* in his bargaining power.

The reason for this counterintuitive finding is as follows. Assume first that the buyer has all the bargaining power, so that he can make a take-it-or-leave-it offer to the seller. If the seller has private information, then the buyer will sometimes sacrifice ex post efficiency in order to reduce the information rent that he must leave to the seller, which may severely diminish his investment incentives. Assume now that the seller has all the bargaining power. If the buyer has private information, then he may enjoy an information rent, provided that his valuation is high. Hence, his incentives to invest in order to increase his valuation may now well be larger than in the case in which he has all the bargaining power. Notice that the result that the buyer's investment is decreasing in his bargaining power can hold only if there is two-sided private information, because the argument just outlined requires that both parties may enjoy information rents.

It should be noted that while most papers on the hold-up problem consider the case of symmetric information, there are some exceptions. In particular, Rogerson (1992) and Schmitz (2002a) show that in a complete contracting world, the hold-up problem can sometimes be solved even under asymmetric information, provided that the trade level is ex ante contractible.[4] In contrast, following the incomplete contracting literature, in the present paper it is assumed that trade is contractible ex post only. Recently, Schmitz (2006) has analyzed the role of asset ownership in an incomplete contracting model with asymmetric information. Yet, this paper

[4]For a more detailed discussion of related papers, see also Schmitz (2001).

considered only one-sided private information, so that the effect highlighted here could not occur.

2 The model

There are two risk-neutral parties, a buyer (B) and a seller (S). At date 1, the buyer chooses an investment level $i \in [0,1]$, which is observable but not verifiable. The investment costs are denoted by $\psi(i)$ and satisfy the standard assumptions $\psi(0) = \psi'(0) = 0$ and $\psi'(i) > 0$, $\psi''(i) > 0$ for all $i > 0$. At date 2, the buyer and the seller may trade one unit of an indivisible good. Let $x \in \{0,1\}$ denote the trade level and let t be a transfer payment from the buyer to the seller. The two parties' payoffs are then given by

$$\begin{aligned} u_B &= xv - t - \psi(i), \\ u_S &= t - xc, \end{aligned}$$

where v, the buyer's value from receiving the good, and c, the seller's cost, are modelled by independent random variables that are realized between dates 1 and 2. The distribution of the seller's cost $c \in \{c_l, c_h\}$ is given by $\Pr\{c = c_l\} = p$, where $p \in (0,1)$. The distribution of the buyer's value $v \in \{v_l, v_h\}$ depends on his investment, $\Pr\{v = v_h | i\} = i$. Thus, the buyer's expected value from getting the good is increasing in his investment level. In order to ensure interior solutions, let $\psi'(1) > v_h - v_l$.

In accordance with many contributions to the incomplete contracting literature,[5] it is assumed throughout that trade is always ex post efficient

[5] See e.g. Hart (1995), Hart et al. (1997), Nöldeke and Schmidt (1998), or Rubinstein

$(c_h < v_l)$, but that it is not possible to fix the terms of trade before date 2.

At date 2, the buyer and the seller bargain over the terms of trade. Following Hart and Moore (1999), it is assumed that the buyer can make a take-it-or-leave-it offer with probability $\alpha \in [0,1]$, while the seller can make a take-it-or-leave-it offer with probability $1-\alpha$.[6] Note that under symmetric information, the bargaining outcome thus corresponds to the generalized Nash bargaining solution, where α denotes the buyer's bargaining power.

The symmetric information benchmark. If the realizations of c and v are observable by both parties, then the party that can make a take-it-or-leave-it offer will demand the whole date-2 surplus for itself. Hence, the buyer's expected date-2 payoff is $\alpha\,[iv_h + (1-i)v_l - pc_l - (1-p)c_h]$ and he will invest i^*, where

$$\psi'(i^*) = \alpha(v_h - v_l).$$

Clearly, the buyer's investment i^* is increasing in his bargaining power α. In particular, if he has all the bargaining power $(\alpha = 1)$, the first-best investment level i^{FB} will be attained, where $\psi'(i^{FB}) = v_h - v_l$. In contrast, the hold-up problem is most severe when the seller has all the bargaining power $(\alpha = 0)$. In the latter case, the buyer will not invest at all. These

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and Wolinsky (1992). Notice that we are looking for the minimal deviation from the symmetric information model that allows the buyer's investment to be decreasing in his bargaining power.

[6] See also Ma (1994), who suggested this simple bargaining game in a moral hazard framework. It has recently also been used by Bajari and Tadelis (2001), who compare cost-plus and fixed-price procurement contracts, and by Schmitz (2006), who studies a property rights model.

benchmark results are still the starting point of most contributions to the incomplete contracting literature (see e.g. Hart and Moore, 2007).

3 One-sided private information

The standard results are qualitatively robust with regard to the introduction of one-sided private information.

Assume first that while the buyer's valuation v is still observable, the seller's cost c is private information (i.e., only the seller learns the realization of c). In this case, if the seller can make a take-it-or-leave-it offer, she still demands the total date-2 pie for herself, so the buyer gets nothing. Yet, if the buyer can make the offer, then he will offer a payment c_h to the seller (which she will always accept) if $v - c_h \geq p(v - c_l)$, while he offers a payment c_l (which the seller will accept with probability p only) otherwise. Hence, the buyer's expected date-2 payoff is $\alpha S(i)$, where

$$S(i) = \begin{cases} iv_h + (1-i)v_l - c_h & if \quad p \leq \frac{v_l - c_h}{v_l - c_l}, \\ i(v_h - c_h) + (1-i)p(v_l - c_l) & if \quad \frac{v_l - c_h}{v_l - c_l} < p \leq \frac{v_h - c_h}{v_h - c_l}, \\ p\left[iv_h + (1-i)v_l - c_l\right] & if \quad p > \frac{v_h - c_h}{v_h - c_l}. \end{cases}$$

The investment level when only the seller has private information, i^S, is thus characterized by $\psi'(i^S) = \alpha S'(i^S)$. It is easy to see that the buyer's investment i^S is still increasing in his bargaining power α.[7]

Next, assume that the seller's cost c is observable, but the buyer's valuation v is his private information. If the buyer can make the offer, he

[7] The marginal return of the investment, $\alpha S'(i)$, is constant in i and increasing in α. Note that in the case $\alpha = 0$ the buyer will not invest at all, while in the case $\alpha = 1$ the first best will be attained if $p \leq (v_l - c_h)/(v_l - c_l)$.

will demand the whole pie; i.e., he offers to pay c. Yet, if the seller can make the offer, then she will demand a payment v_l if $v_l - c \geq i(v_h - c)$, and a payment v_h otherwise. Hence, the buyer's expected date-2 payoff is $\alpha\left[iv_h + (1-i)v_l - pc_l - (1-p)c_h\right] + (1-\alpha)B(i)$, where

$$B(i) = \begin{cases} i(v_h - v_l) & if \quad i \leq \frac{v_l - c_h}{v_h - c_h}, \\ ip(v_h - v_l) & if \quad \frac{v_l - c_h}{v_h - c_h} < i \leq \frac{v_l - c_l}{v_h - c_l}, \\ 0 & if \quad i > \frac{v_l - c_l}{v_h - c_l}. \end{cases}$$

The investment level when only the buyer has private information is $i^B = \arg\max \alpha i(v_h - v_l) + (1-\alpha)B(i) - \psi(i)$. It is straightforward to check that the investment level is (weakly) increasing in α.[8] To summarize, we can thus state the following result.

Proposition 1 *When there is either symmetric information or one-sided private information, then the buyer's investment level is increasing in his bargaining power α.*

It should be noted that there is never overinvestment with respect to the first-best investment level, which will also be true in the case of two-sided private information.[9]

[8]The marginal return of the investment (which now is a decreasing step function in i) is independent of α for $i \leq (v_l - c_h)/(v_h - c_h)$ and strictly increasing in α otherwise. Note that in the case $\alpha = 0$ the first best will be attained if $i^{FB} \leq (v_l - c_h)/(v_h - c_h)$, while the first best is always attained in the case $\alpha = 1$.

[9]Overinvestment may occur in a non-standard hold-up model, where the buyer's investment influences the distribution of the seller's cost (see the buyer-seller example in Maskin and Moore, 1999, for a hold-up problem with a direct externality; see also

4 Two-sided private information

Assume now that there is two-sided private information; i.e., only the seller learns the realization of c and only the buyer learns the realization of v. In this case, the standard results may well be overturned.

The investment level under two-sided private information is $i^{**} = \arg\max \alpha S(i) + (1-\alpha)B(i) - \psi(i)$. The marginal return of the investment is displayed in Table 1. Note that the marginal return is a decreasing step function in i (in each of the three columns, the marginal return becomes smaller when we move down). The buyer will invest as long as the marginal return is larger than the marginal investment cost $\psi'(i)$. Note that the marginal returns in the second and third row are (weakly) increasing in α. Hence, if the marginal investment costs are sufficiently small, then the investment level will again be increasing in α.

However, consider now the case in which the marginal investment costs are large, so that we are always in the first row; i.e., assume that $i^{FB} \leq (v_l - c_h)/(v_h - c_h)$.[10] In the first column, where $p \leq (v_l - c_h)/(v_l - c_l)$, the first-best investment level will be attained regardless of the bargaining power. Yet, in the second and third column, where $p > (v_l - c_h)/(v_l - c_l)$, the marginal returns of the investment are decreasing in α. Hence, in stark

the subsequent work by Che and Hausch, 1999, De Fraja, 1999, and Schmitz, 2002b). Assume for a moment that i is exogenously fixed but the buyer can invest to increase p. If v is private information, $\alpha = 0$, and $(v_l - c_h)/(v_h - c_h) < i \leq (v_l - c_l)/(v_h - c_l)$, then there is overinvestment when $i(v_h - v_l) > c_h - c_l$. If c is private information and $\alpha = 1$, overinvestment occurs when the marginal investment costs are sufficiently small.

[10] In other words, the marginal investment costs satisfy $\psi'(i) > v_h - v_l$ for $i \geq (v_l - c_h)/(v_h - c_h)$.

contrast to the standard results, the investment level is *strictly decreasing* in α.

	$p \leq \frac{v_l - c_h}{v_l - c_l}$	$\frac{v_l - c_h}{v_l - c_l} < p \leq \frac{v_h - c_h}{v_h - c_l}$	$p > \frac{v_h - c_h}{v_h - c_l}$
$i \leq \frac{v_l - c_h}{v_h - c_h}$	$v_h - v_l$	$v_h - v_l$ $-\alpha[p(v_l - c_l) - (v_l - c_h)]$	$v_h - v_l$ $-\alpha(1-p)(v_h - v_l)$
$\frac{v_l - c_h}{v_h - c_h} < i$ $\leq \frac{v_l - c_l}{v_h - c_l}$	$p(v_h - v_l)$ $+\alpha(1-p)(v_h - v_l)$	$p(v_h - v_l)$ $+\alpha[v_h - c_h - p(v_h - c_l)]$	$p(v_h - v_l)$
$i > \frac{v_l - c_l}{v_h - c_l}$	$\alpha(v_h - v_l)$	$\alpha[v_h - c_h - p(v_l - c_l)]$	$\alpha p(v_h - v_l)$

Table 1. The buyer's marginal return of his investment.

Proposition 2 *When there is two-sided private information and the marginal investment costs are sufficiently large, then the buyer's investment level is decreasing in his bargaining power* α.

As an illustration, consider the case $c_l = 0$, $c_h = 3/4$, $v_l = 1$, $v_h = 4/3$, $p = 1/2$, and $\psi(i) = i^2/2$. Then the buyer's investment is $i^{**} = 1/3 - \alpha/6$, which is decreasing in α.[11]

[11] Note also that under symmetric information, the investment level would be $i^* = \alpha/3$. Hence, under asymmetric information the investment level is *larger* than under symmetric information if $\alpha < 2/3$.

5 Concluding remarks

As has been pointed out in the literature (see e.g. Hart and Moore, 2007), it may sometimes be possible to allocate date-2 bargaining power at some initial date 0. Clearly, in the case of symmetric information that has usually been studied, at date 0 the parties would always agree to give the investing party the right to make a take-it-or-leave-it offer at date 2. However, if the parties know that there will be asymmetric information, the model studied here implies that they might well agree to allocate all the bargaining power to the non-investing party.[12]

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[12] At date 0, the parties agree to allocate bargaining power in order to maximize the expected total surplus, which they can divide using up-front payments. For instance, in the example mentioned below Proposition 2, they would agree on $\alpha = 0$, which allows them to generate the first-best surplus.

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