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ABSTRACT

Information Gathering and the Hold-Up Problem in a Complete Contracting Framework*

In a complete contracting model, a risk-neutral seller exerts effort while producing a good. Effort is a hidden action and stochastically influences the risk-neutral buyer's valuation. Then the buyer can gather private information about his valuation. The ex ante optimal contract may encourage information gathering, even though it is commonly known that it is ex post efficient to trade regardless of the buyer's valuation (so that information gathering is a strategic, unproductive rent-seeking activity). Information gathering occurs even more often if it is a verifiable action.

JEL Classification: D82 and D86
Keywords: complete contracting, hold-up problem and information gathering

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1 Introduction

In traditional agency theory, the information structure is taken as given.[1] More recently, economists have begun to study agency models with an endogenous information structure. In this literature, one can distinguish between situations in which information gathering is a productive activity or strategic rent-seeking only.[2] For example, consider a buyer and a seller who can trade a good. If the buyer's valuation may be larger or smaller than the seller's cost depending on the state of the world, then the ex post efficient trade decision requires information gathering. Hence, provided that information gathering is not too costly, it is a productive activity that should be encouraged. However, if it is common knowledge that the buyer's valuation is always positive while the seller's costs are zero, then the buyer should not waste any resources in order to learn his valuation. Nevertheless, the buyer might gather information in order to enjoy an information rent when the seller can make a take-it-or-leave-it offer. In this case, information gathering is a strategic rent-seeking activity only and should be discouraged from an ex ante perspective.

In the present paper, it is argued that there is a natural class of problems in which information gathering is a strategic rent-seeking activity (i.e., no productive decision is based on the private information), while nevertheless the parties will write a contract that deliberately encourages information gathering.

Specifically, consider the following situation. There are two risk-neutral parties, a buyer and a seller, who can trade a good at some future date 2. There are no relevant wealth constraints. At date 0, they can write a complete contract (in the sense of Tirole, 1999). At date 1, the seller invests unobservable effort in the production of the good. While it is commonly known that the buyer's valuation for the good is positive, he must spend some resources if he wants to privately learn the exact value (i.e., the buyer

[1] See Laffont and Martimort (2002) for an excellent textbook exposition.

[2] See Crémer, Khalil, and Rochet (1998b) and the literature discussed below.

can inspect the good after it has been produced). The effort costs are sunk at date 2 and the seller has no other use for the good; i.e., at date 2 it is always ex post efficient to trade. Hence, information gathering is a pure rent-seeking activity that would never be pursued in a first-best world.

If the seller's investment level were verifiable, the buyer would never waste resources to learn his value. The parties would contractually specify that the seller must make the efficient investment and that the good is always traded. At date 0, the parties would agree on a fixed price with which they could divide the expected first-best surplus according to their bargaining powers. If the parties failed to write a suitable contract and the seller could make a take-it-or-leave-it offer to the buyer ex post, then the buyer would be tempted to spend resources in order to learn his valuation, so that he would enjoy an information rent. Hence, the contract written at date 0 serves to discourage information gathering.

Yet, the results are quite different if the seller's investment is a hidden action. If the buyer does not spend resources to learn his valuation, then the payment that the seller receives cannot be made contingent on the state of the world. But if the seller's payment is constant, she will have no incentive to invest. Thus, in order to give the seller an incentive to invest, it is necessary that the buyer gathers information. In other words, if the parties want to implement a high investment level, then they will have to write a contract that encourages information gathering, even though it is a rent-seeking activity that has no productive purpose when it is undertaken.

The main result of the present paper is a full characterization of the optimal contract in the setting just outlined. It will turn out that the parties induce the buyer to gather information if the seller's investment costs and the buyer's information gathering costs are sufficiently low. In this case, the parties will distort the trade level downwards in the bad state of the world, just as in models with precontractual private information (although in the current setting, the parties are symmetrically informed when they write the contract). Moreover, it will be demonstrated that even more information

gathering occurs when the buyer's decision whether or not to gather information is verifiable.

This paper is related to two different branches of the contract theoretic literature. First, there are by now several papers that endogenize the information structure in otherwise traditional adverse selection models, see Crémer and Khalil (1992, 1994) and Crémer, Khalil, and Rochet (1998a, 1998b). Moreover, in the incomplete contracting literature, Aghion and Tirole (1997) and Dewatripont and Tirole (1999) study models in which information gathering is a productive activity that is to be encouraged by the choice of the governance structure. In contrast, Schmitz (2006) considers strategic information gathering in a property rights model (cf. Hart, 1995) and argues that the optimal ownership structure can serve the purpose to discourage information gathering. Second, the present paper is related to the literature on solutions of the hold-up problem in complete contracting models. While most papers in this literature assume complete information, Rogerson (1992) and Schmitz (2002) analyze the case of asymmetric information. Yet, in contrast to the present paper, they do not endogenize the information structure.[3]

2 The model

There are two risk-neutral parties, a buyer and a seller. At date 0, they can write a complete contract with regard to the production and the terms of trade of a specific good.[4] At date 1, the seller decides whether she exerts

[3]Note also that the present paper considers investments with direct externalities. See the buyer-seller example in Maskin and Moore (1999) for an analysis of such investments in an incomplete contracting framework. See also the subsequent work of Che and Hausch (1999), DeFraja (1999), and Rosenkranz and Schmitz (1999).

[4]Hence, there are no ad hoc restrictions on the class of feasible contracts. In particular, renegotiation can be ruled out. Maskin and Tirole (1999) argue that differing assumptions in the incomplete contracting literature are motivated by considerations that lie outside the existing models. In any case, the complete contracting framework is an important benchmark.

high effort ($e = e_h$) or low effort ($e = e_l$) while she produces the good, where $0 < e_l < e_h < 1$. The seller's decision is a hidden action and her disutility of effort is denoted by $c(e)$, where $c(e_l) = 0$ and $c(e_h) = c > 0$.

The buyer's valuation for the good is high ($v = v_h$) with probability e and low ($v = v_l$) with probability $1 - e$, where $v_h > v_l > 0$. If the buyer invests $\psi > 0$ after the good has been produced, then he privately learns his valuation v. Otherwise, the buyer remains uninformed. At date 2, trade can occur and payments are made according to the contract.

Let $x \in [0, 1]$ denote the trade level and let t be the transfer payment from the buyer to the seller. Hence, the seller's payoff is given by $t - c(e)$. The buyer's payoff is given by $xv - t - \psi$ if he gathers information and by $xv - t$ otherwise. The reservation utilities of the parties are zero.

Note that it is always ex post efficient to trade, regardless of the buyer's valuation. Thus, in a first-best world, the buyer would not waste any resources in order to learn the valuation. Moreover, in a first-best solution, high effort would be exerted by the seller if $c < (e_h - e_l)(v_h - v_l)$.

3 The second-best

Assume first that the buyer's decision whether or not to invest ψ into information gathering is a hidden action. We will consider direct revelation mechanisms which prescribe a trade level $x(\tilde{v})$ and a transfer payment $t(\tilde{v})$ contingent upon the buyer's announcement of his type, $\tilde{v} \in \{v_l, v_u, v_h\}$, where the message v_u means that the buyer claims to be uninformed. For notational simplicity, let (x_l, t_l), (x_u, t_u), and (x_h, t_h) represent the alternatives between which the buyer can choose. The incentive compatibility conditions which make truth-telling an optimal strategy for the buyer are

$$x(v)v - t(v) \geq x(\hat{v})v - t(\hat{v}) \qquad \forall v, \hat{v} \in \{v_l, v_u, v_h\}^2,$$

where $v_u = ev_h + (1 - e)v_l$ when effort level e is implemented. If the buyer is induced to gather information, the seller is willing to choose high effort

whenever the following incentive compatibility condition is satisfied:

$$e_h t_h + (1 - e_h) t_l - c \geq e_l t_h + (1 - e_l) t_l.$$

This condition can be rewritten as

$$t_h - t_l \geq \frac{c}{e_h - e_l}.$$

When the buyer is not induced to gather information, the seller will never choose high effort, because in this case she always gets the payment t_u, regardless of the state of the world.

Note that the parties are symmetrically informed at date 0. Hence, according to the Coase Theorem, they will always write a contract that makes the expected total surplus as large as possible. They can divide the expected total surplus between them by suitable lump-sum components of the payments.[5]

Proposition 1 *i) If $c \geq (e_h - e_l)(v_h - v_l)$, then there is no information gathering, the parties implement low effort, and trade always takes place; i.e., the first-best solution is attained.*

ii) If $c < (e_h - e_l)(v_h - v_l)$, then the first-best solution requires high effort. In this case, it is impossible to achieve the first best, regardless of ψ.

It is trivial to implement the first best when the effort costs are so large that low effort would be chosen even in a first-best world. In this case, the parties contractually specify $x_l = x_u = x_h = 1$ and a lump-sum payment $t_l = t_u = t_h$ in order to divide the expected total surplus between them. Clearly, the seller will choose the low effort level and the buyer will not spend any resources to gather information. In order to focus on the interesting case, in the remainder of the paper we make the following assumption.

[5] It depends on the parties' ex ante bargaining powers how they divide the expected total surplus. For example, if the buyer is a "principal" who can make a take-it-or-leave-it offer, then he will extract the expected total surplus, so that the seller's expected payoff is zero.

Assumption 1. $c < (e_h - e_l)(v_h - v_l)$.

We have already seen that the seller will never choose $e = e_h$ if the buyer remains uninformed, because then the transfer payment that the seller gets cannot depend on the buyer's valuation. Hence, if high effort is to be implemented, the information gathering costs ψ must be incurred, which never happens in a first-best world. Yet, there must be an additional deviation from the first best if the parties want to implement high effort. Since it is always ex post efficient to trade, the truth-telling constraints imply a constant transfer payment when the parties insist on first-best trade levels. Hence, the seller would not exert high effort if the parties did not give up ex post efficiency sometimes.

The following proposition characterizes the optimal contract provided that the parties want to implement high effort.

Proposition 2 *High effort can be implemented if and only if* $\psi \leq e_h(1 - e_h)(v_h - v_l)$. *If the parties implement high effort, then information gathering is induced and the optimal contract has the following properties.*

- *If* $\psi \leq \frac{e_h(1-e_h)(v_h-v_l)}{(e_h-e_l)(e_h v_h+(1-e_h)v_l)}c$, *then* $x_h = 1$, $x_l = x_u = 1 - \frac{c}{(e_h-e_l)v_h} - \frac{\psi}{e_h v_h}$, $t_h - t_l = \frac{c}{e_h-e_l}$, $t_u = t_l$.
- *Otherwise,* $x_h = x_u = 1$, $x_l = 1 - \frac{\psi}{e_h(1-e_h)(v_h-v_l)}$, $t_h - t_l = \frac{e_h v_h+(1-e_h)v_l}{e_h(1-e_h)(v_h-v_l)}\psi$, $t_u = t_h$.

Proof. Suppose that the parties want to implement $e = e_h$, so that the buyer must have an incentive to gather information. The problem of the buyer and the seller is to maximize the expected total surplus $e_h x_h v_h + (1 - e_h) x_l v_l - c - \psi$ subject to the buyer's truth-telling constraints

$$\begin{aligned}
(x_h - x_l)v_l &\leq t_h - t_l \leq (x_h - x_l)v_h, \\
(x_u - x_l)v_l &\leq t_u - t_l \leq (x_u - x_l)v_u, \\
(x_h - x_u)v_u &\leq t_h - t_u \leq (x_h - x_u)v_h,
\end{aligned}$$

the buyer's information gathering constraint

$$e_h(x_h v_h - t_h) + (1 - e_h)(x_l v_l - t_l) - \psi \geq x_u v_u - t_u$$

with $v_u = e_h v_h + (1 - e_h) v_l$, the seller's incentive compatibility constraint

$$t_h - t_l \geq \frac{c}{e_h - e_l},$$

and the feasibility constraints according to which x_l, x_u, and x_h must be in the unit interval. Note that the truth-telling constraints imply $x_h \geq x_u \geq x_l$. In what follows, we can ignore $(x_h - x_l)v_l \leq t_h - t_l \leq (x_h - x_l)v_h$, because it is implied by the remaining constraints. Obviously, in the optimum $x_h = 1$ must hold, because otherwise x_h, x_u, and x_l could be increased by the same small amount without violating any side constraints. Next, note that the buyer's information gathering constraint and the truth-telling constraints for the type v_u together imply $(1 - x_l)\, v_l + \frac{\psi}{1-e_h} \leq t_h - t_l \leq (1 - x_l)\, v_h - \frac{\psi}{e_h}$. Hence, $\psi \leq e_h(1 - e_h)\,(1 - x_l)\,(v_h - v_l)$ must hold. As a consequence, if $\psi > e_h(1-e_h)(v_h - v_l)$, then it is impossible to implement high effort. Otherwise, $x_l \leq 1 - \frac{\psi}{e_h(1-e_h)(v_h - v_l)}$ must hold. Moreover, the seller's incentive compatibility constraint and $t_h - t_l \leq (1 - x_l)\, v_h - \frac{\psi}{e_h}$ imply $x_l \leq 1 - \frac{c}{(e_h - e_l)v_h} - \frac{\psi}{e_h v_h}$. Clearly, the parties want to set x_l as large as possible. Thus, consider $x_l = \min\left\{1 - \frac{c}{(e_h - e_l)v_h} - \frac{\psi}{e_h v_h}, 1 - \frac{\psi}{e_h(1-e_h)(v_h - v_l)}\right\}$. It is then straightforward to show that all constraints of the problem are satisfied by the claimed solution. ■

Hence, if the parties want to implement high effort, they agree on a contract according to which information gathering occurs and the trade level is distorted downwards in the bad state of the world. While the latter property is similar to standard adverse selection models (see Maskin and Riley, 1984), the reason is quite different. In particular, recall that in the present model there is no precontractual private information, without which there would be no distortion in standard adverse selection models.[6] The reason why here there is a distortion is the fact that this allows the transfer payment in the

[6] See d'Aspremont and Gérard-Varet (1979). As a consequence, the distortion identified

bad state of the world to be smaller than in the good state, which is necessary in order to give the seller an incentive to invest.

Proposition 3 *The parties implement high effort as characterized in the previous proposition whenever*

$$\begin{aligned}\psi \quad \leq \quad & \min\left\{e_h(1-e_h)(v_h-v_l), \frac{e_h(e_h-e_l)(v_h-v_l)^2}{e_hv_h+(1-e_h)v_l} - \frac{e_h(v_h-v_l)}{e_hv_h+(1-e_h)v_l}c,\right. \\ & \left.\frac{e_h(e_h-e_l)(v_h-v_l)v_h}{e_hv_h+(1-e_h)v_l} - \frac{(1-e_h)v_l+(e_h-e_l)v_h}{(e_h-e_l)(e_hv_h+(1-e_h)v_l)}e_hc\right\}.\end{aligned}$$

Otherwise, the parties implement low effort. In this case, there is no information gathering and $x_h = x_u = x_l = 1$, $t_h = t_u = t_l$.

Proof. If the parties implement low effort, the expected total surplus is $e_lv_h + (1-e_l)\,v_l$. Hence, if $\psi \leq \frac{e_h(1-e_h)(v_h-v_l)}{(e_h-e_l)(e_hv_h+(1-e_h)v_l)}c$, then the parties implement high effort whenever the expected total surplus $e_hv_h + (1-e_h)\,(1 - \frac{c}{(e_h-e_l)v_h} - \frac{\psi}{e_hv_h})v_l - c - \psi$ is larger than $e_lv_h + (1-e_l)\,v_l$. Analogously, if $\frac{e_h(1-e_h)(v_h-v_l)}{(e_h-e_l)(e_hv_h+(1-e_h)v_l)}c < \psi \leq e_h(1-e_h)(v_h-v_l)$, then the parties implement high effort whenever the expected total surplus $e_hv_h + (1-e_h)\,(1 - \frac{\psi}{e_h(1-e_h)(v_h-v_l)})v_l - c - \psi$ is larger than $e_lv_h + (1-e_l)\,v_l$. The proposition then follows in a straightforward way. ■

The parties implement high effort whenever the information gathering costs ψ and the investment costs c are sufficiently small. For example, consider the case illustrated in Figure 1.[7] In the region below the solid curve, there is information gathering and high effort is implemented, while there is a downward distortion of the trade level in the bad state of the world. Otherwise, there is no information gathering and low effort is implemented, while ex post efficiency is achieved.

here does not depend on who proposes the contract. In contrast to models with precontractual private information (or models with binding wealth constraints), in the present setting the ex ante bargaining powers determine only the division of the expected total surplus, but not its size.

[7] In the figure, $e_l = v_l = 0.4$ and $e_h = v_h = 0.8$.

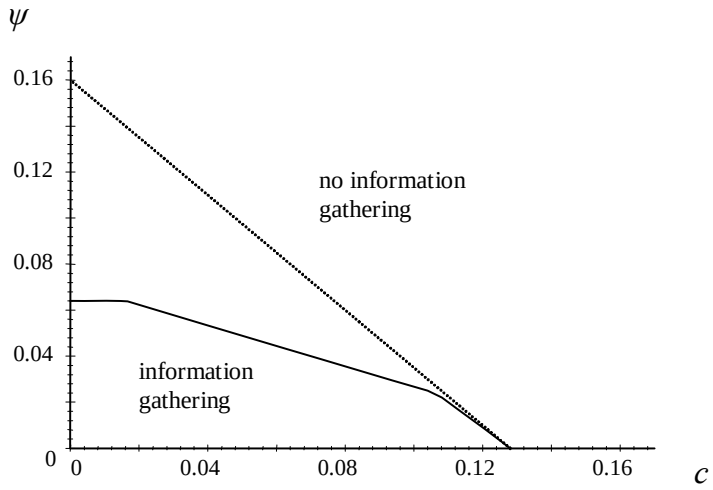

Figure 1.

Finally, one might ask what happens if the buyer's decision whether or not to gather information is verifiable. It turns out that even though in the present model information gathering is a strategic rent-seeking activity, making this activity verifiable leads to more information gathering. Specifically, the following result holds.

Proposition 4 *Assume that the buyer's information gathering decision is verifiable.*

- *If* $\psi \leq (e_h - e_l)(v_h - v_l) - \frac{e_h v_h + (1-e_h)v_l - e_l v_h}{v_h(e_h - e_l)} c$, *then the parties agree on information gathering, they implement high effort, and* $x_h = 1$, $x_l = x_u = 1 - \frac{c}{(e_h - e_l)v_h}$, $t_h - t_l = \frac{c}{e_h - e_l}$, $t_u = t_l$.
- *Otherwise, there is no information gathering, low effort is implemented, and* $x_h = x_u = x_l = 1$, $t_h = t_u = t_l$.

Proof. The parties' problem is similar to the one considered in Proposition 2, the only difference is the fact that now the buyer's information

gathering constraint is no longer relevant. It is then straightforward to check that high effort will be implemented as claimed in the proposition. The parties will implement high effort if the resulting expected total surplus $e_h v_h + (1 - e_h)(1 - \frac{c}{(e_h - e_l)v_h})v_l - c - \psi$ is larger than $e_l v_h + (1 - e_l) v_l$, the expected total surplus when they implement low effort. Thus, the proposition follows immediately. ■

In the example displayed in Figure 1, when the buyer's decision to gather information is a verifiable action, then in the region below the dotted line, there is information gathering and high effort is implemented. Otherwise, there is no information gathering and low effort is implemented. Hence, there are now more parameter constellations in which information gathering occurs. In contrast, recall that if the seller's effort level were verifiable, then information gathering would never occur.

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