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Contract design and bargaining power

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Abstract

It is a common assumption in contract theory that the uninformed side makes a take-it-or-leave-it proposal. In contrast, this paper explores a model which allows a shift in bargaining power continuously between the two parties. Endowing the informed side with more bargaining power gradually reduces distortions. © 2002 Elsevier Science B.V. All rights reserved.

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1. Introduction

Contract design under (one-sided) private information has found widespread application over the last three decades. Typically, it is assumed that the uninformed party designs the proposal. Unified treatments have been provided by Laffont and Maskin (1982) and Guesnerie and Laffont (1984). Examples where this theory has been applied are abundant, for example labor contracts, optimal taxation, price and quality discrimination, public goods, and regulation of monopoly. A major assumption is that the principal has all the bargaining power when designing the contract. This may be reasonable if there is competition between various (sufficiently homogeneous) agents. However, in this case, picking an agent (randomly) and making a take-it-or-leave-it offer is generally not the optimal mechanism. On the other hand, if there is indeed only one suitable agent, it may be reasonable to assume that he should also enjoy some bargaining power. This paper shows that contractual distortions depend crucially on the distribution of bargaining power. In particular, distortions gradually vanish as bargaining power shifts to the informed agent.¹

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¹The role of bargaining power for the efficiency of implemented contracts has also been analyzed by Ma (1994) for the case of moral hazard under renegotiations.

2. Model

We consider a setting where an uninformed party (the principal) contracts with an informed party (the agent) to produce quantity $q \geq 0$ of some good. The contract also prescribes a payment y made by the principal. The agent, who may represent a monopolistic firm, has private information about his type $i \in I = \{1, 2\}$. Payoffs are given by $y - C_i(q)$ for the agent and by $W(q) - y$ for the principal. Failure of agreement is equivalent to choosing $q = 0$, where $C_i(0) = 0$ and $W(0) = 0$. Total surplus is aggregated by $S_i(q) = W(q) - C_i(q)$. All functions are two times continuously differentiable in q . Moreover, we make the following standard assumptions.

Assumption 1. $d^2 S_i / dq^2 < 0$ with $\lim_{q \rightarrow \infty} d^2 S_i / dq^2 < 0$, $C_2(q) > C_1(q)$ for $q > 0$, $dC_2/dq > dC_1/dq > 0$, $d^2 C_2/dq^2 \leq d^2 C_1/dq^2$.

Denote first-best quantities by q_i^* , where we assume that $q_2^* > 0$. Note that Assumption 1 implies $q_1^* > q_2^*$ and that $S_1^* > S_2^* > 0$, where $S_i^* = S_i(q_i^*)$. We now specify the game. In the first period $n = 0$ the principal may propose a menu of contracts. If the agent accepts, he can pick any contract in the menu. Contracts are not open to further renegotiations. If the agent rejects, the game proceeds into the final round $n = 1$, where the principal (agent) can propose with probability $0 < p < 1(1 - p)$. The number $1 - p$ represents a measure of the agent's bargaining power. We look for equilibria where players' strategies are sequentially optimal and where the principal consistently updates his beliefs. In what follows, we will only require the following parsimonious notation. Denote the principal's prior beliefs in $n = 0$ by $v^0 = \Pr(i = 1)$. We assume that $0 < v^0 < 1$. Along a given equilibrium path of offers and responses, we will denote the acceptance probability of type i in period $n = 0$ by π_i . If equilibrium strategies prescribe rejection in $n = 0$ (for some type with positive probability), we denote the principal's beliefs (derived by consistent updating) in $n = 1$ by v^1 .

3. Equilibrium

Suppose that the proposal in $n = 0$ was unsuccessful. If the agent proposes in $n = 1$, he offers a first-best contract and realizes the payoff S_i^* . If it is the principal's turn to make a proposal, we encounter a standard game of screening.

To solve for the game at $n = 0$ we first consider an auxiliary screening game with type-dependent reservation values U_i^R for $i \in I$. Hence, we solve for a menu of two acceptable contracts $\{(q_i^S, y_i^S)\}_{i \in I}$ which maximize

$$v[W(q_1^S) - y_1^S] + (1 - v)[W(q_2^S) - y_2^S],$$

subject to the individual rationality constraints $y_i^S - C_i(q_i^S) \geq U_i^R$, denoted by IR_i , and the incentive compatibility constraints $y_i^S - C_i(q_i^S) \geq y_j^S - C_i(q_j^S)$ for $j \neq i$, denoted by IC_i . Note that v represents the principal's beliefs. We restrict reservation values U_i^R as follows:

$$\begin{aligned} S_i^* &\geq U_i^R \geq 0 \text{ for } i \in I, \\ U_1^R &\geq U_2^R, \\ U_1^R - U_2^R &\leq S_1^* - S_2^*. \end{aligned} \tag{1}$$

It can be shown that (1) allows us to focus on the following three candidates:²

Candidate (S1). In this case only IR_2 and IC_1 are binding. We obtain $q_1^S = q_1^*$, while q_2^S maximizes the high-cost type’s ‘virtual surplus’:

$$(1 - v)S_2(q) - v\Phi(q), \tag{2}$$

where we use $\Phi(q) = C_2(q) - C_1(q)$. Observe that (2) is concave by Assumption 1. If the derivative of (2) at $q = 0$ is not strictly positive, we obtain the corner solution $q_2^S = 0$. Otherwise, $q_2^S > 0$ is uniquely determined by the first-order condition. We introduce for this candidate the function $q_2^S = \bar{q}_2^{S1}(v)$, which is continuous and nonincreasing in v with $\bar{q}_2^{S1}(0) = q_2^*$. Finally, transfers satisfy $y_2^S = U_2^R + C_2(q_2^S)$ and $y_1^S = y_2^S + \Phi(q_2^S)$.

Candidate (S2). In this case only IR_1 , IR_2 , and IC_1 are binding, implying $y_i^S = U_i^R + C_i(q_i^S)$, $q_1^S = q_1^*$, and for q_2^S the requirement

$$\Phi(q_2^S) = U_1^R - U_2^R. \tag{3}$$

Candidate (S3). In this case only IR_1 and IR_2 are binding, yielding $q_i^S = q_i^*$, while transfers are given by $y_i^S = U_i^R + C_i(q_i^*)$.

It is now straightforward to derive the following result (see, for instance, Inderst, 1997; Jullien, 2000):

Lemma. *Suppose the restrictions in (1) apply. The screening program under which the principal must offer both types an acceptable contract has a unique solution. This depends on the difference $U_1^R - U_2^R$ as follows:*

- (i) *Candidate (S1) applies iff $0 \leq U_1^R - U_2^R \leq \Phi(\bar{q}_2^{S1}(v))$.*
- (ii) *Candidate (S2) applies iff $\Phi(\bar{q}_2^{S1}(v)) < U_1^R - U_2^R < \Phi(q_2^*)$.*
- (iii) *Candidate (S3) applies iff $\Phi(q_2^*) \leq U_1^R - U_2^R$.*

This result has the following intuition. Observe that the principal’s choice generally trades off the maximization of expected surplus with the minimization of the information rent left to the low-cost type. This trade-off is maximal if both types have the same reservation value $U_1^R = U_2^R$. As the difference in reservation values $U_1^R - U_2^R$ increases, the trade-off is mitigated and disappears completely if $U_1^R - U_2^R \geq \Phi(q_2^*)$, where both contracts implement the respective first-best choices of q .

Choose now $U_i^R = (1 - p)S_i^*$ and set $v = v^0$. It is shown below that solving for an equilibrium of the game essentially reduces to solving for the optimal screening proposal for this specification. Denote the respective menu as specified in the lemma by $\{(\bar{q}_i, \bar{y}_i)\}_{i \in I}$, which gives rise to the following result proved below.

²A similar analysis has been carried out in Inderst (1997) and Jullien (2000).

Proposition. *The bargaining game has an equilibrium where $\{(\bar{q}_i, \bar{y}_i)\}_{i \in I}$ is implemented in the first period $n = 0$. Moreover, in any equilibrium of the game the following results hold:*

- *The high-cost type implements (\bar{q}_2, \bar{y}_2) in the first period.*
- *The low-cost type implements only the first-best choice $\bar{q}_1 = q_1^*$ and receives the (expected) transfer \bar{y}_1 .*

Hence, equilibrium payoffs and quantities are unique. By combining the lemma with the proposition, we obtain our main result.

Corollary. *There exist values $0 < \underline{p} < \bar{p} < 1$ such that the menu $\{(\bar{q}_i, \bar{y}_i)\}_{i \in I}$ is determined by (S1) for $p \geq \bar{p}$, by (S2) for $\underline{p} < p < \bar{p}$, and by (S3) for $p \leq \underline{p}$. This has the following implications for equilibrium quantities:*

- *The choice for the low-cost type $i = 1$ is always efficient.*
- *The choice for the high-cost type $i = 2$ is only efficient if the agent's bargaining power is sufficiently high ($p \leq \underline{p}$). Moreover, the quantity for the high-cost type is continuous and nonincreasing in p , while it decreases strictly over $\underline{p} < p < \bar{p}$.*

Hence, the distortion in the contract for the high-cost type gradually decreases as the agents's bargaining position, as expressed by the term $1 - p$, becomes more favorable. The agent's option to wait until the second period to (possibly) make a counteroffer essentially transforms the principal's problem into one with type-dependent reservation values.³ As the agent's bargaining power increases, the difference in the reservation values of high- and low-cost types widens. This gradually erodes the profitability of (information) rent extraction by the principal in the first period.

4. Proof of the proposition

If an agent does not contract in $n = 0$, he expects to make a (final) offer in $n = 1$ with probability $1 - p$, in which case he realizes just S_i^* . If it is the principal's turn to make the offer in $n = 2$, it is immediate that the high-cost type will not realize more than zero. These observations yield the following result.

Lemma A1. *In any equilibrium of the game, the expected payoff of type i is bounded from below by $(1 - p)S_i^*$. Moreover, the high-cost type's utility in the continuation game starting at $n = 1$ is equal to $(1 - p)S_2^*$.*

Suppose now the principal offers in $n = 0$ a menu containing a contract (q, y) where $y > C_2(q) +$

³Previous literature has derived type-dependent reservation values, for example from initial contracts as in Laffont and Tirole (1990b), from bypass products as in Laffont and Tirole (1990a), or from competition as in Stole (1995), Armstrong and Vickers (1999) and Inderst (1999). On countervailing incentives, see also Lewis and Sappington (1989) and Bradburd and Srinagesh (1989).

$(1 - p)S_2^*$. Lemma A1 implies that the high-cost type must accept. Suppose now that the equilibrium response of the low-cost type prescribes that he rejects the principal's offer with positive probability. Consistent updating implies that the principal's posterior beliefs satisfy $v^1 = 1$ in the case of rejection. From this it follows that the low-cost type must realize exactly $(1 - p)S_1^*$ if his equilibrium strategy prescribes rejection with positive probability. Hence, in case the principal's menu offered in $n = 0$ also contains a contract (q', y') satisfying $y' > C_1(q') + (1 - p)S_1^*$, the menu must be accepted by both types. As a consequence, the principal can end the game in $n = 0$ by offering a menu under which each type realizes more than $(1 - p)S_i^*$. As a consequence, the menu $\{(\bar{q}_i, \bar{y}_i)\}_{i \in I}$ (with a marginal adjustment in transfers) would be accepted by both types in $n = 0$.

Lemma A2. *The expected payoff realized under the screening menu $\{(\bar{q}_i, \bar{y}_i)\}_{i \in I}$ provides a lower boundary for the principal's payoff in any equilibrium of the game.*

To obtain also an upper boundary on the principal's payoff, we proceed by introducing the following auxiliary problem: suppose the principal can design a mechanism which prescribes for type i that he implements in period n the contract $(\hat{q}_i^n, \hat{y}_i^n)$ with probability $\hat{\pi}_i^n$, where $\hat{\pi}_i^1 + \hat{\pi}_i^2 = 1$. The mechanism must satisfy individual rationality and incentive compatibility:

$$\sum_{n=0}^1 \hat{\pi}_i^n (\hat{y}_i^n - C_i(\hat{q}_i^n)) \geq U_i^R = (1 - p)S_i^* \text{ for } i \in I, \tag{4}$$

$$\sum_{n=0}^1 \hat{\pi}_i^n (\hat{y}_i^n - C_i(\hat{q}_i^n)) \geq \sum_{n=0}^1 \hat{\pi}_j^n (\hat{y}_j^n - C_i(\hat{q}_j^n)) \text{ for all } i, j \in I. \tag{5}$$

As there is no discounting, implementing different contracts with some type i in the two periods $n = 0, 1$ serves only as a randomization device. By standard arguments, Assumption 1 ensures that this is not (strictly) optimal. The following result is then straightforward.

Lemma A3. *Consider the auxiliary problem of designing an optimal mechanism for the principal (over the two periods $n = 0, 1$ with constraints (4) and (5)). Any solution has the following properties:*

- each type i implements with probability 1 the respective value \bar{q}_i ;
- the (expected) transfer to each type is uniquely determined and equal to \bar{y}_i .

Note that by Lemma A1 the principal's payoff in the two-stage game surely cannot exceed his payoff obtained under the considered mechanism. Hence, the lower boundary derived in Lemma A2 also constitutes an upper boundary on his payoff.

If there is no agreement in $n = 0$, the agent proposes in $n = 1$ with probability $1 - p > 0$, where q_i^* is implemented. If this happens with $i = 1$ along the equilibrium path, Lemma A3 now implies that the principal realizes strictly less than under the menu $\{(\bar{q}_i, \bar{y}_i)\}_{i \in I}$, which contradicts Lemma A2. As a consequence, the game with $i = 2$ must in any equilibrium end in $n = 0$ by implementing (\bar{q}_2, \bar{y}_2) .

Consider now the low-cost type. By Lemmas A1 and A3 we can again conclude that he must implement his first-best choice $\bar{q}_1 = q_1^*$ with probability 1 and that his expected utility must be equal to that realized under (\bar{q}_1, \bar{y}_1) .

We have therefore proved that any equilibrium must be as characterized in the proposition.

Existence can be easily established by using Lemma A3 and optimistic beliefs which put $v^1 = 1$ on rejection.

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