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Information provision before a contract is offered

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HIGHLIGHTS

- We study the agent's incentives to provide information before contracting.
- We investigate how the agent's expected rent changes with the principal's belief.
- We show that the agent may provide a bad signal to the principal.
- The principal is better-off when her information is updated.

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ABSTRACT

This paper considers an agency model in which the agent can update the principal's belief before the contract is offered. We identify that the agent who has a bad potential to perform the task has a small chance to receive information rent, but if he receives it, he receives a large amount. Thus, the agent may choose to provide more information that shifts the principal's belief to the negative direction if the prior belief is optimistic.

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1. Introduction

In a standard principal–agent model, the only uninformed party at the outset is the principal and her belief is not updated until the agent reveals his information after accepting the contract. In practice, both the principal and the agent often have imperfect information on the agent's type before participation, but the agent can strategically influence the principal's belief before the contract is offered. For example, the supplier in an outsourcing relationship may not know the cost of production until studying the product details after contracting with the buyer, but the supplier can make a brief blueprint and present it to the buyer before the contract offer. The supplier can make a blueprint to strategically influence the buyer's belief about the production cost. Similarly, while an organization's mission is public knowledge, job candidates may not know their exact fit for the mission. One can strategically choose to provide information for or against his suitability.

Using a simple agency model, we study the agent's strategic public effort to update the principal's belief before the contract is offered.[1] In our model, the agent learns his true type only after participation. We identify that, although updating the principal's belief in the negative direction decreases the agent's chance of receiving rent, such an action increases the amount of rent if he receives it. This trade-off makes the expected rent inverse U-shaped and concave. As is well-known, when the value function is concave, a sender does not benefit from additional information provision. In our setting, however, the principal may want to contract only with the agent whose type matches the task (the good type), if her prior belief about the agent's type is highly optimistic. In such a case, the agent receives no rent regardless of his type. Thus, the agent's expected rent is non-continuous in the

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[1] To focus on strategic effects, we assume that such an effort is costless in this paper.

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principal's belief. Then, the agent with a good potential for the task may have an incentive to shift the principal's belief to the negative direction. In equilibrium, the agent may choose to increase the amount of negative information to the principal, while limiting the amount of positive information. In addition, more information from the agent makes the principal always better off, regardless of the direction of her belief update.

In the principal–agent literature, there are studies on the agent's incentive to acquire private information before contracting (e.g. Cremer and Khalil, 1992; Cremer et al., 1998; Hoppe and Schmitz, 2010).[2] The literature, however, has paid little attention to the agent's incentive to update the principal's belief by providing information before a contract is offered, which is our main focus in this note. Kessler (1998) shows that the agent may have an incentive to be uninformed with a strictly positive probability at the point of the contract offer. In her model, the uninformed agent remains ignorant after participation and pooling between the inefficient type and the ignorant type can arise depending on the parameters. The pooling increases the output level associated with the inefficient type, which in turn increases the efficient type's rent. In our model, no pooling arises in the optimal contract since the agent is perfectly informed upon participation.

The next section presents the model, followed by the main section that presents our results. All proofs are relegated to Appendix.

2. Model

Players and payoffs. Consider the standard agency model (e.g. Baron and Myerson, 1982; Laffont and Martimort, 2002) with adverse selection. A risk-neutral principal contracts with a risk-neutral agent to produce output level $q \in \mathbb{R}^+$. The principal's revenue function, $S(q)$ satisfies $S'(q) > 0$, $S''(q) < 0$, $S'''(q) = 0$ and Inada condition. The principal's payoff is $\pi = S(q) - T$, where T is the payment transfer to the agent.

The agent's type is the cost parameter of production, denoted by $\theta \in \{\theta_G, \theta_B\}$, where $\Delta\theta \equiv \theta_B - \theta_G > 0$. The agent's payoff is $u = T - \theta q$. At the outset, neither the principal nor the agent knows the true θ, but they have a common prior belief $p_0 \in (0, 1)$ that $\theta = \theta_G$, that is $\Pr(\theta = \theta_G) = p_0$ and $\Pr(\theta = \theta_B) = 1 - p_0$. The agent privately observes true θ, only after participation. We assume that the agent can quit anytime if he expects a payoff less than the reservation level, denoted by $\underline{u} > 0$.[3]

Information provision. Before the principal offers the contract, the agent can update the common belief. To be specific, the agent can engage in some public activities that send a signal $s \in \{s_G, s_B\}$. We will refer to s_G as the good signal and s_B as the bad signal. As is standard, the signal is imperfect in the sense of Blackwell and:

$$\Pr(s_G|\theta = \theta_G) = \alpha_G \quad \text{and} \quad \Pr(s_B|\theta = \theta_B) = \alpha_B,$$

where $\alpha_G, \alpha_B \in \left[\frac{1}{2}, 1\right]$ without loss of generality. The signal s_i becomes more informative as α_i approaches 1, and less informative as α_i approaches 1/2. Thus, α_G and α_B can be interpreted as the agent's choice of amount of information that becomes public before the principal offers the contract—α_G (α_B) is the agent's public activity level that is more likely to send a good (bad) signal to the principal.[4]

After $s \in \{s_G, s_B\}$ is realized, all parties update the common belief. We refer to p_G and p_B as the posterior beliefs conditional on s_G and s_B, respectively. Bayes' rule then gives:

$$p_G \equiv \Pr(\theta = \theta_G|s_G) = \frac{\alpha_G p_0}{\alpha_G p_0 + (1-\alpha_B)(1-p_0)} \quad \text{and}$$

$$p_B \equiv \Pr(\theta = \theta_G|s_B) = \frac{(1-\alpha_G)p_0}{\alpha_B(1-p_0) + (1-\alpha_G)p_0}.$$

Signals disperse the prior belief to two-point distribution in the sense of a mean-preserving spread: p_G with the probability $\Pr(s_G)$, and p_B with $\Pr(s_B)$. The probabilities that the principal receives a good and a bad signal are respectively:

$$\Pr(s_G) = \sum_{\theta \in \{\theta_G, \theta_B\}} \Pr(s_G|\theta)\Pr(\theta) \quad \text{and}$$

$$\Pr(s_B) = \sum_{\theta \in \{\theta_G, \theta_B\}} \Pr(s_B|\theta)\Pr(\theta).$$

Timing. The timing of the game is as follows.

- *Stage* 1: The principal and the agent share a prior belief p_0. The agent chooses α_G and α_B. Depending on a realized signal $s \in \{s_G, s_B\}$, they obtain a posterior belief $p \in \{p_G, p_B\}$.
- *Stage* 2: The principal offers $(q_i, T_i)^{i\in\{G,B\}}$ to the agent. If the offer is accepted, the agent privately observes $i \in \{G, B\}$ and sends a report on it. The agent produces q_i according to his report on i, and the principal pays T_i.

Benchmark. As a benchmark, we consider the optimal outcome under full information. The first-best output schedule, denoted by q_i^*, is characterized by: $S'(q_i^*) = \theta_i,\ i \in \{G, B\}$. The agent receives no information rent in any case.

3. Optimal contract

In light of backward induction, we first discuss the principal's problem at Stage 2, with a posterior belief p obtained at the end of Stage 1. Then we discuss the agent's choice at Stage 1.

The principal's problem and the agent's rent

Our aim here is to identify the agent's information rent for different ranges of p. The principal's problem is:

$$\max_{\{(t_G,q_G);(t_B,q_B)\}} E[\pi] = p\left[S(q_G) - T_G\right] + (1-p)\left[S(q_B) - T_B\right],$$

subject to:

$$T_i - \theta_i q_i \geq T_j - \theta_i q_j \quad i, j \in \{G, B\}, \tag{IC_i}$$

$$T_i - \theta_i q_i \geq \underline{u}, \quad i \in \{G, B\}. \tag{PC_i}$$

The first constraint, (IC_i), induces the agent's truthful report, while the second constraint, (PC_i), induces the agent's participation.

Definition 1. Define $\widetilde{p}$ by: $\frac{\widetilde{p}}{1-\widetilde{p}}\Delta\theta\widehat{q}_B(\widetilde{p}) + \underline{u} = \widehat{\pi}_B(\widetilde{p})$, where:

$$S'(\widehat{q}_B(p)) \equiv \theta_B + \frac{p}{1-p}\Delta\theta \quad \text{and}$$

$$\widehat{\pi}_B(p) \equiv S(\widehat{q}_B(p)) - \theta_B\widehat{q}_B(p).$$

With the definition above, we present the optimal outcome in the following lemma.

Lemma 1. *Given any posterior belief p, the optimal contract is characterized by:*

- *For $p \leq \widetilde{p}$, $q_G = q_G^*$ and $q_B = \widehat{q}_B(p) < q_B^*$. The agent receives rent of $\Delta\theta\widehat{q}_B(p)$ only when $i = G$.*
- *For $p > \widetilde{p}$, $q_G = q_G^*$ and $q_B = 0$. The agent receives no rent.*

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[2] In Cremer and Khalil (1992), the agent's information gathering effort is purely strategic whereas in Cremer et al. (1998) such effort is productive. Hoppe and Schmitz (2010) compare the principal's and the agent's welfares of the two cases.

[3] In our model, $\underline{u} > 0$ gives rise to the possibility that the contract may entail $q = T = 0$ when $\theta = \theta_B$. Alternatively, one can assume $\underline{u} = 0$ and remove the Inada condition, in particular, $S'(0) = \infty$.

[4] The agent's choice of α_G and α_B is comparable to the control of information generation in Brocas and Carrillo (2007) and Bayesian persuasion in Kamenica and Gentzkow (2011).

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