

Information Provision and Employment Relationship*

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December 28, 2012

Abstract

We examine the choice of employment relationship for a two-period production process wherein initially both parties do not know the ability of the agent for the task and where the principal has the option to costlessly provide precise information on the agent's ability to the agent. We find that the principal prefers to have a flexible employment relationship with information provision if the project is large; a flexible relationship but no information provision if the project is of medium size; while an exclusive relationship with information provision if the project is small. The comparative statics of principal's employment choice with respect to morale problem and sorting problem are also explored.

Keywords: Career Concern, Information Structure, Contracts, Effort Distortion, Employment

JEL classification: D82, D83, D86, J63, L23, M12, M51, M52

*I would like to thank Emmanuelle Auriol, Philippe Bontems, Jacques Crémer, Jiangli Dou, Patrick Rey, Michael Riordan, Patrick Schmitz, Dezso Szalay, Jean Tirole, and Ruqu Wang for helpful comments and suggestions! The idea of this paper is originated from the chapter 2 of my Ph.D. dissertation submitted to Toulouse School of Economics. All errors are of my own.

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1 Introduction

Information incompleteness is ubiquitous in the economy and is a common assumption in the principal-agent models. In the labor economics literature, it is commonly assumed that both sides are symmetrically uninformed and they learn a productivity-related parameter over time (Jovanovic 1979b, Oyer and Schaefer 2010). Recently, there is literature that studies the cases when the principal has the option to get informed (see, e.g., Crémer 1995 and Kaya 2010), or the agent has the option to gather information (see, e.g., Crémer and Khalil 1992, Kessler 1998).

There is few literature that explores the case where the principal can take actions (job assignment, turnover, and so on) to influence the agent's information structure. The assignment of jobs to individuals is a big and important issue in organizations. In this paper, we study a principal-agent model in which the principal decides how to hire agent(s) for a two-period production process. The production is newly invented or firm specific, initially the principal and any agent in the labor market cannot know the agent's matched ability with this production. Should the principal employ the same agent to perform production in both periods, or is it better to keep the flexibility to switch to another agent if she finds the previous agent is more likely with low matched ability? After the employment modes is chosen, should the principal choose to provide information to the agent and make the agent precisely learn his ability or not? The costs and benefits of flexible employment and information provision that are highlighted in this paper are based on incentive concern due to moral hazard and adverse selection problems.

In practice, there are lots of examples for the employment relationship mentioned above. For instance, most firms employ in house lawyers to deal with regular legal affairs, outside lawyers with few interaction for contract dispute, and outside lawyers with depth communication (the lawyers can access to richer firm's resources and information) for antitrust cases. Most firms also adopt job transfers as a motivation device.

Specifically, we consider the following two-period production process involving a principal (or employer, firm, etc.) and one or two agents (or employees). *Ex ante*, the agents/employees are identical. That is to say, "there are no good workers or good

employers; there are only good matches” (Jovanovic 1979a). In this paper, good matches are characterized by better performance of the agent than bad matches. Before work begins, neither the employer nor the employee can know whether the employee will be well matched with the job and therefore he will be productive in this job. The agent’s productivity depends not only on the effort he exerts but also on the quality of the match between the task and the agent. The quality of the match is initially unknown but revealed over time. We call the well matched and hence productive employee a capable or high quality employee; and a mismatched and hence less productive employee, a bad or low quality employee. The employer cannot observe effort. But the output is observable by all and contractible, so the contracts contingent on its value can be written.

The principal needs to hire an agent in each period to undertake the production. Initially she can choose to exclusively employ one agent or keep the flexibility to fire the agent if she finds the agent is not competent at the end of the first period. We do not exogenously assume any information difference between these two employment relationship. At the end of the first period, the employee may learn whether he is well matched with the specific job or not according to the informational environment. In the meantime, the principal can commit to provide information to the agent so that the agent can perfectly learn his ability at the end of the first period or not. There is also learning after the first period for the employer, as past performance is relevant in updating the information about the quality of the employee-job matching. In the second period, there is agency problem, since through the process of the contract, the agent may perfectly learn his ability while the principal could only Bayesian update her belief about the agent’s ability. Hence informational asymmetries arise.

When the relationship is not exclusive, the agent has incentive from career concern and is eager to exert high effort in the first period production and try to prove that he is more competent. The principal can also reduce the possibility to retain a non-capable agent. The information provision of the principal has two effects: when the agent can perfectly learn his ability after one period and he knows that the principal knows this, then the agent has less career concern since he knows that the principal knows that he knows his ability and then the principal can screen the agent; and now

the principal knows that the agent knows his own ability, she can sort the capable agent more efficiently and reduce the chance to dismiss a competent agent with bad luck.

We find that the optimal employment modes depend on the relative size of the project, the sorting problem, and also the morale concern. Given all other parameters fixed, when the size of the project, the morale problem, or the sorting problem is small, the principal prefers to have an exclusive relationship with information provision; when the size of the project is medium, the morale problem is medium, or the sorting problem is big, the principal prefers to have a flexible relationship but no information provision; while when the size of the project is large, the morale problem is big, or the sorting problem is medium, the principal prefers to have a flexible relationship with information provision.

1.1 Literature

This paper is closely related to the literature on task assignment and job design. Ickes and Samuelson (1987) study the effect of job transfers on incentives and find that job transfers make the information from the agent's experience useless for the future task and hence may diminish the ratchet effect. Schmitz (2005) compares the job assignment arrangements where one agent takes in charge of both periods or one agent only for one period when the tasks in two periods are complementary and where the information structure is exogenously given for each relationship.

There are some papers deal with the principal's choice on information provision in a fixed principal-agent relationship. Sobel (1993) studies the effect of the timing when the agent knows the information about his ability on principal's payoff in a static one period model and finds that the principal prefers an agent who can get information about his ability to an agent who never knows the information when there are two outcomes. When there are three outcomes, he proposes an example where the result may reverse. Lewis and Sappington (1991) examine when the principal would let the agent receive perfect private state information in the Baron-Myerson (1982) model and find that the principal either provide perfect information or no information to the agent (all-or-nothing). Continuing with the concern on information management,

Lewis and Sappington (1994) explore the question when the seller would allow its potential buyers to acquire private information about their tastes for the seller's product and also find the result of all-or-nothing information control. The trade-off in all these papers is between the informational rent extraction and efficiency. My paper studies a two period model and the efficiencies are the same in all information structures, but the power of incentives are different for different information structures. The effort in the first period will affect the information structure in the second period.

The plan of the paper is as follows: We present the setup in Section 2. Then we analyze the optimal contracts and information choice in the flexible relationship in Section 3. After that we study the case for the exclusive relationship in Section 4. We investigate the optimal employment modes and various comparative statics in Section 5. We deploy various extensions in Section 6. Finally we conclude in Section 7.

2 The Model

The principal has a project which lasts for two periods and needs to be implemented by an agent. We assume that the probability of a good match between the agent and the project is exogenously given and equals to $p \in (0, 1)$. The mismatched employee always has a productivity of zero, while the productivity of the matched employee depends on his effort. There are only two effort levels: 0 and 1. The cost of effort 1 is one dollar and it yields a profit of B with probability q_h and of 0 with probability $(1 - q_h)$. Effort 0, brings no dis-utility, yields profits of B with probability q_l and of 0 with probability $(1 - q_l)$. Without loss of generality, I assume that $q_h > q_l$. Following the job match models, I assume that the quality of the match is learned over time but that the actual value, which is B , of the match is fixed.

Information Structure: Since observed productivity in previous period yields information relevant to assessing managerial ability, it is necessary to describe the learning process more completely. We assume that the principal can only update her belief about the agent's ability through Bayesian rule by observing the agent's performance in the first period. The quality is unknown to the agent, and must

be learned by observing performance or through an learning process (investigation, experience or communication with other colleagues). During or after the first period, the principal can give instruments (for example, access to some assets) to the agent so that the agent can learn precisely his matched ability to the task. The principal can also deter the agent from learning anything about his match with the task except the performance in the first period (for example, creating tension between the agent and his working environment (colleagues or physical assets)). At the end of the first period, the agent can be fully informed or just Bayesian informed depending on the principal's action, no matter the relationship is long term or short term. We will prove that when employing exclusively an agent for both period the principal will always make the agent informed, while when having a flexible employment relationship the principal's choice depends on the economic environment.

Timing: The game that the parties are playing can therefore be described as follows:

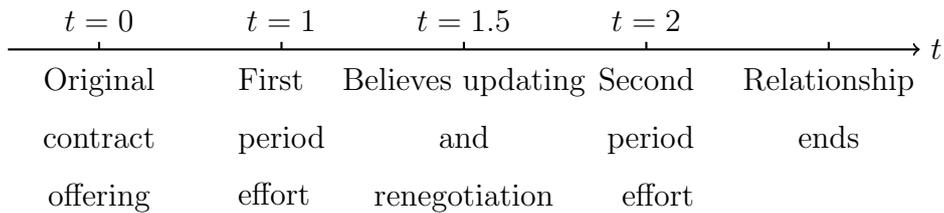


Figure 1: Timeline

Initially, the principal offers a contract to the agent. If it is in the principal's interest, she will make the agent fully informed after one period, otherwise the agent keep Bayesian updating. If the agent accepts the contract, the agent chooses his first period effort. After the first period performance is chosen by the nature, if the contract in force requires it, the principal fires the employee after paying him any salary that she owes him and hires another employee. If the contract in force requires it, the principal helps the agent to learn his ability. Having observed the first period performance, the employer decides whether or not to propose a new contract to the employee who decides whether or not to accept it. Then, the employee acting in the second period chooses his second period effort. Nature chooses the second period

performance. In the end, the employee is rewarded according to the terms of the contract.

Spot contracts: Before we formally analyze the contract in this two periods setup, it is useful to explore the spot contracts in each period. In the first period, there is no information asymmetry, both the principal and the agent just know the distribution of the future matched productivity. According to the above assumptions, the wage contract can be contingent on the performance, not the effort, so the agent will exert effort only when the expected benefit $pq_h w - 1$ is larger than the benefit when shrinking $pq_l w$. That is to say, the optimal spot wage is: $w = \frac{1}{p\delta}$, where $\delta = q_h - q_l$, and the expected payoff for the principal is $S = pq_h B - \frac{q_h}{\delta}$. If the principal does not want to induce high effort, she will offer the wage 0 and obtain the profit $pq_l B$. If it is worthwhile for the principal to induce high effort when both parties do not know the quality of the match, the value of the match B must satisfy the following assumption.

Assumption 1 $B > \frac{q_h}{p(q_h - q_l)^2}$

In the second recurrent spot market, if the principal knows the agent is of good quality, the optimal spot contract would be $w = \frac{1}{\delta}$ and the expected payoff for the principal is $S' = q_h B - \frac{q_h}{\delta}$. If the principal knows the agent is of bad quality, it is beneficial to dismiss the agent and to recruit a new one if she can. If the agent knows his own type and the principal only knows that the agent knows his type, not the exact type of the agent, the principal needs to provide a contract which could not only motivate the agent to exert effort but also screen the good type. This spot contract will be discussed in Section 3.1.

Contracts: Since the productivity of the mismatched agent is always zero, it is beneficial for the principal to continue the relationship if the first period performance is high. If the agent's performance is high and hence the trading parties continue their relationship, a second period contract is applicable and the agent is paid $w(B0)$ if his performance in the second period is low and $w(BB)$ if his performance in the second period is high. If the first period performance is low, the trading parties can decide to continue or to terminate their relationship. If the relationship is terminated, the agent get payment $w(0)$. If the relationship is continued, the agent get payment $w(00)$

if the second period performance is low and $w(0B)$ is the second period performance is high. If the principal terminates the relationship with the first period agent, she hires a new agent from the market and the incentive scheme for the second period spot market is described below.

Before proceeding further, it is necessary to clarify the renegotiation process. Following Benoît and Krishna (1993) and Wang (2000), we call a one period contract renegotiation-proof if it brings the principal the highest payoff among all feasible and incentive compatible one period contracts, and a two periods contract renegotiation-proof if it brings the principal the highest payoff among all feasible and incentive compatible two periods contracts whose one period continuations are renegotiation-proof. When studying renegotiation proof labor contract, Dewatripont (1989) focuses on a renegotiation procedure where only the uninformed party makes offers.

In section 3, we first explore the optimal contract arrangement when the firm has a flexible employment contract and the employee can break contracts and work elsewhere, and the employer can also break contracts and fire the employee. The employer can also provide contracts which would make the employees quit voluntarily. The contract is provided before the interaction between potential labors and employers. In section 4, we consider the case where the principal sign an exclusive contract with the agent, and the principal and the agent are locked in the relationship: they cannot break the contract between them and have to keep interacting for two periods.

3 Flexible Relationship and Information Structure

In this section, we analyze the case where trading parties have flexible relationship. The principal can fire the agent and hire a new one after one period and the agent can also quit the interaction with the principal. We first analyze the case where the principal let the agent know precisely his ability after one period interaction in subsection 3.1, then the case she does not let the agent know precisely in subsection 3.2.

3.1 Information Provision

In this subsection, we study the case where the agent is informed after one period and the principal knows that the agent knows his type precisely. This is the case where the principal *ex ante* provides access to some essential assets to the agent so that the agent can be fully informed.

When the principal knows that the agent knows his type, the principal can provide a screening contract which induces the bad agent to leave the interaction and the good agent to stay within the interaction and exert high effort. The compensation scheme $(w(B), w(0)) = (\frac{1}{\delta}, 0)$ can motivate the good agent to exert high effort if the principal knows that the agent is good. Under this compensation scheme, if the bad agent mimics as good agent, his gain is always zero. Hence this scheme can also screen a good agent and the bad agent would leave the interaction with this principal if he is provided with this contract. Since there is no extra cost to screening, it is optimal to provide this screening contract. It is easy to show that the principal obtains the highest payoff with this contract.

The problem of the principal can be written as:

$$\max_{w(\cdot)} pq_h [q_h (2B - w(BB)) + (1 - q_h) (B - w(B0))] + p(1 - q_h) S' + (1 - p) (S - w(0))$$

The first part is the expected gain of the principal if the agent is good and his performance in the first period is high. When the performance of the agent in the first period is low, the principal proposes the contract $(w(B), w(0)) = (\frac{1}{\delta}, 0)$, then the good agent will stay in the second period and exert high effort and the bad agent will quit. The second part is the expected gain of the principal if the agent is good but his performance in the first period is low. The third part is the expected gain of the principal if the performance in the first period is low and the old agent chooses to quit and the principal hires a new agent from the market. The principal's program is equivalent to

$$\max_{w(\cdot)} pq_h [-q_h w(BB) - (1 - q_h) w(B0)] - (1 - p) w(0).$$

The benefit of the agent to exert effort in the first period is

$$pq_h [(q_h w(BB) + (1 - q_h) w(B0)) - 1] + p(1 - q_h) \left(\frac{q_h}{\delta} - 1 \right) + (1 - p) w(0) - 1.$$

The first part is the expected gain if his type is good and performance is high in the first period, the second part is the expected benefit if he is a good type but unlucky in the first period, the third part is the expected gain if he is a bad type and the fourth part is the effort cost. The benefit if he does not exert effort is:

$$pq_l [(q_h w(BB) + (1 - q_h) w(B0)) - 1] + p(1 - q_l) \left(\frac{q_h}{\delta} - 1 \right) + (1 - p) w(0).$$

Hence, to motivate the agent to exert effort, the compensation plan should satisfy the following first period incentive compatibility (FIC) constraint:

$$q_h w(BB) + (1 - q_h) w(B0) \geq \frac{q_h}{\delta} + \frac{1}{p\delta}$$

Therefore, the optimal compensation scheme would satisfy the second period incentive compatibility constraint and $q_h w(BB) + (1 - q_h) w(B0) = \frac{1}{p\delta} + \frac{q_h}{\delta}$.

Straightforwardly, we get that the expected payoff of the principal is

$$\pi_1 = pq_h \left[(3 - p) B - \frac{2}{p\delta} \right]. \quad (1)$$

The expected gain of the agent is equal to $(1 + p) \left(\frac{q_h}{\delta} - 1 \right)$.

Renegotiation Proofness: When the agent is informed, he learns his type perfectly after one period. The principal can design a screening contract for the second period, which provides payment $\frac{1}{\delta}$ to the agent if the performance is high and nothing if it is low. One can see that only the agent who knows he is good type would stay within the relationship with the principal. The principal can provide an independent incentive contract for the first period which provides incentive wage $\frac{1}{p\delta}$. This contract arrangement is renegotiation proof. Obviously this contract satisfies the conditions for the optimal contract in this subsection.

3.2 No Information Provision

When the agent cannot access to any other information besides his performance, if the performance in the first period is low, the principal would just dismiss the agent and hire a new employee from the market, since now the screening contract would not work and the updated belief that the old agent is good is lower than the probability that a

new agent from the market is good. We will show that this contract is renegotiation proof. Therefore, now the principal's program is as follows:

$$\begin{aligned} & \max_{w(\cdot)} pq_h [q_h (2B - w(BB)) + (1 - q_h) (B - w(B0))] + (1 - pq_h) (S - w(0)) \\ & \Leftrightarrow \max_{w(\cdot)} pq_h [-q_h w(BB) - (1 - q_h) w(B0)] - (1 - pq_h) w(0) \end{aligned}$$

subject to:

$$\begin{aligned} w(BB) & \geq w(B0) + \frac{1}{\delta}, \\ q_h w(BB) + (1 - q_h) w(B0) - 1 & \geq w(0) + \frac{1}{p\delta}, \\ w(BB), w(B0), w(0) & \geq 0. \end{aligned}$$

It is clear that the optimal solution of the above problem should satisfy:

$$\begin{aligned} w(0) & = 0 \\ w(BB) & \geq w(B0) + \frac{1}{\delta}, \\ q_h w(BB) + (1 - q_h) w(B0) & = \frac{1}{p\delta} + 1, \\ w(BB), w(B0) & \geq 0. \end{aligned}$$

Therefore we get that the optimal compensation scheme should satisfy the SIC constraint, limited liability constraint and $q_h w(BB) + (1 - q_h) w(B0) = \frac{1}{p\delta} + 1$. The principal's payoff is:

$$\begin{aligned} \pi_2 & = pq_h \left[(2 - pq_h) \left(B - \frac{1}{p\delta} \right) + Bq_h - 1 \right] \\ & = pq_h \left[B(2 + q_h - pq_h) - \frac{2 - pq_h}{p\delta} - 1 \right]. \end{aligned} \quad (2)$$

The expected gain of the agent is equal to

$$pq_h [q_h w(BB) + (1 - q_h) w(B0) - 1] + (1 - pq_h) w(0) - 1 = \frac{q_h}{\delta} - 1$$

Renegotiation Proofness: The principal would just rehire the agent if his performance in the first period is high. After observing high performance, the principal knows that the agent is good type. If the principal provides two independent contracts to the agent. The principal needs to provide incentive wage of $\frac{1}{\delta}$ to the rehired

agent. Since the agent can expect that if his performance in the first period is high, the principal would rehire him and provide the contract above. Anticipating this, the principal would just need to provide the incentive wage which equals to $1 + \frac{1}{p\delta} - \frac{q_h}{\delta}$ to motivate the agent to exert effort in the first period. The contract scheme described above satisfies the conditions I get in this subsection.

Career Concern: The incentive salary is lower comparing to the one in subsection 3.1. It is because whether the principal would keep the agent does not depend on the effort exerted by the agent in the first period in the case with information provision. Now, the agent needs to exert more effort to prove that he is of good type so that the principal would rehire him, which provides extra incentive to the agent besides the performance salary for the first period.

By comparing the principal's payoff when she interacts with agent in different information structures, we get the following proposition:

Proposition 1 *When the employment relationship is flexible, the principal prefers not providing information if $B < \frac{q_l}{(1-p)(1-q_h)\delta}$.*

In fact, when deciding whether to provide more information to the agent with flexible contract, the principal needs to balance the trade-off between incentive effect and sorting effect. If she does not provide extra information, the information is symmetric between these two parties, the agent is partially motivated by career concern. The principal needs to pay less incentive salary, but she also may dismiss a good agent with bad luck in the first period and hence suffer from efficiency loss. If she provides information, the information between these two parties are asymmetric. The agent knows perfectly his ability and he knows that the principal knows that he knows she knows his ability, and so on. Then the agent knows that the principal would adopt a screening contract to sort and retain the good quality agent even if he is with bad luck in the first period. Hence, now the principal needs to pay more to motivate the agent to exert effort in the first period. But she can surely keep the good agent and suffers no efficiency loss.

We know that the incentive effect dominates the sorting effect if the condition in proposition 1 stands, which is equivalent to (one of) the following conditions stands given the other parameters:

- The value of the project, B , is small,
- The probability that the agent is good type, p , is really high,
- The success rate, q_h and q_l , is high for the good agent no matter effort is exerted or not,
- The effect of the effort on the success of the project, δ , is small.

When one of the conditions above stands, the agent works harder for tenure if he has no more information; while the informed agent has no worry about the tenure since he knows that the principal will use an incentive contract to attract and keep him even if his performance in the first period is low. Comparing to the value of the project, it is too costly to use incentive contracts. Therefore, the principal prefers an agent with less information, who is partially motivated by career concern.

4 Exclusive Relationship and Information Structure

In this section, we reconsider the information provision problem in an exclusive relationship where there is no firing at the beginning of the second period. When the agent can get fully informed at the end of the first period, the contract with the agent is the same as in subsection 3.1. The only difference is that even if the agent's ability is low, the principal cannot switch to a new agent in the market. Now, the principal's expected profit is:

$$\begin{aligned}\pi_3 &= pq_h[q_h(2B - w(BB)) + (1 - q_h)(B - w(B0))] + p(1 - q_h)S' \\ &= 2pq_hB - \frac{q_h}{\delta}(1 + p).\end{aligned}\tag{3}$$

If the principal does not provide more information to the agent, the strategy of the agent is complex. On the one hand, the agent can keep his position in the second period and have no career concern, hence he will exert less effort in the first period. On the other hand, the agent may want to exert higher effort in the first period in such a way that he can sort himself and does not waste effort in the second period.

We need to explore which effect dominates. When the agent knows that his ability is low, he will exert zero effort in the second period. When the agent can only get informed partially from performance and the performance in the first period is low, 0, the updated belief that the agent is high quality is $p_2 = \frac{p(1-q_h)}{1-pq_h}$ if the agent is exerting high effort in the first period. To motivate the agent to exert effort in the second period when the performance in the first period is low, the incentive wage $w(0B)$ should satisfy

$$p_2q_hw(0B) - 1 \geq p_2q_lw(0B),$$

therefore $w(0B) = \frac{1}{p_2\delta}$. The expected payoff of the principal is $p_2q_hB - \frac{q_h}{\delta}$. If the principal does not motivate the agent to exert effort, she will offer the wage of 0 and the expected payoff of the principal is p_2q_lB . To make sure that it is still beneficial for the principal to motivate the agent to exert high effort, we need to assume that $B > \frac{q_h}{p_2\delta^2}$.

The expected income for the agent to exert effort in the first period is

$$pq_h[q_hw(BB) + (1 - q_h)w(B0) - 1] + (1 - pq_h)p_2(q_h\frac{1}{p_2\delta} - 1) - 1. \quad (4)$$

If the agent did not exert effort in the first period, his belief on his high ability is $p'_2 = \frac{p(1-q_l)}{1-pq_l}$, and the expected benefit he could get is:

$$pql[q_hw(BB) + (1 - q_h)w(B0) - 1] + (1 - pq_l)p'_2(q_h\frac{1}{p_2\delta} - 1). \quad (5)$$

Therefore, in order to motivate the agent to exert effort, the wages $w(BB)$, $w(B0)$ should make the value in equation(4) larger than the value in equation (5), which is equivalent to:

$$q_hw(BB) + (1 - q_h)w(B0) \geq \frac{1}{p\delta} + \frac{q_h}{p_2\delta}.$$

In this environment, the principal's programming problem is as follows:

$$\max pq_h[q_h(2B - w(BB)) + (1 - q_h)(B - w(B0))] + (1 - pq_h)p_2q_h(B - w(0B))$$

subject to:

$$\begin{aligned} w(BB) &\geq 0, w(B0) \geq 0, w(0B) \geq 0, \\ q_hw(BB) + (1 - q_h)w(B0) &\geq \frac{1}{p\delta} + \frac{q_h}{p_2\delta}. \end{aligned}$$

The optimal wage package should satisfy

$$q_h w(BB) + (1 - q_h)w(B0) = \frac{1}{p\delta} + \frac{q_h}{p_2\delta},$$

and the principal's expected profit is

$$\pi_4 = 2pq_h B - \frac{q_h}{\delta} \left(1 + \frac{1 - pq_h}{1 - q_h}\right). \quad (6)$$

Since $1 - pq_h > 1 - q_h$, we have $\frac{1 - pq_h}{1 - q_h} > 1 > p$, and $\pi_4 < \pi_3$. Ex ante, the expected efficiency (profit) of the agent is the same no matter he is informed or not. The expected wage for the agent is higher when he is with less information. Since now the principal is stuck with the agent. The agent has no career concern, while he needs to take the effect of his effort in the first period on the second period incentive wage into account, which is mentioned as ratchet effect. The agent knows that if his performance in the first period is good, the incentive wage will decrease from $\frac{1}{p_2\delta}$ to $\frac{1}{\delta}$. Hence, when the information is symmetric between these two parties, the principal needs to pay more to motivate the agent to exert high effort. When the principal provides information to the agent, the principal just needs to pay $\frac{1}{p\delta}$ to motivate the agent to exert effort in the first period. While if the principal chooses not to provide information, she needs to pay $\frac{1}{p\delta} + \frac{q_h(1-p_2)}{p_2\delta}$.¹ To summarize it, we get the following proposition:

Proposition 2 *When the principal signs an exclusive employment contract with the agent, she always prefers to provide information.*

5 Optimal Employment Relationship

Now we come back to the beginning of the first period and let's see how the principal chooses her optimal employment arrangement. Comparing the profits, π_1 and π_2 when the principal provides flexible contracts, and π_3 when she provides exclusive contracts, we obtain the following result, which is also summarized in Table 1.

¹There is a conflict between the principal and the agent on whether to make the agent informed. The agent is willing to stay ignorant while it is in the principal's interest to ask the agent to be informed.

Table 1: The relationship between the employment modes and the project size (measured by B).

Return of the Project	Employment Relationship	Information Structure
large	flexible	informed
medium	flexible	uninformed
small	exclusive	informed

Proposition 3 *It is optimal for the principal to have a flexible relationship with information provision if the size of the project is large; a flexible relationship but no information provision if the project is of medium size; while an exclusive relationship with information provision if the size of the project is small.*

Proof. We have already compared the profit levels between π_1 and π_2 in section 3, and get the result that $\pi_1 \geq \pi_2$ if $B \geq \frac{q_l}{(1-p)(1-q_h)\delta}$. Here we just need to compare the case when the principal has a flexible relationship with no information provision and the case when the principal has an exclusive relationship with the agent.

When the principal provides a flexible contract but no information provision, from equation (2), we know that the expected gross benefit is: $pq_h(2 + q_h - pq_h)B$, and the expected payment to the agent is: $\frac{2q_h}{\delta} + pq_h - \frac{pq_h^2}{\delta}$. If the principal provides an exclusive contract with information provision, from equation (3), we know that the expected gross benefit is: $2pq_hB$, and the expected payment to the agent is: $\frac{q_h + pq_h}{\delta}$. The gain from trade with a flexible relationship is larger than that with an exclusive relationship, while the transaction cost or the total transfer to the agent could also be larger.

The difference of the expected gross benefit between the case with flexible contract but no information provision and the case with exclusive contract and information provision is

$$DB = 2pq_hB - pq_h(2 + q_h - pq_h)B = -(1-p)q_hB$$

which is negative.

The difference of the expected gross cost between these two cases is

$$\begin{aligned} DC &= \frac{q_h + pq_h}{\delta} - \left(\frac{2q_h}{\delta} + pq_h - \frac{pq_h^2}{\delta} \right) \\ &= \frac{(p(1 + pq_l) - 1)q_h}{\delta}. \end{aligned}$$

It is beneficial for the principal to sign an exclusive contract only if $DB > DC$. When $p(1 + q_l) > 1$, we know that $DC > 0 > DB$ and therefore the principal is better-off to have a flexible contract with no information. When $p(1 + q_l) < 1$,

$$\begin{aligned} DB - DC &= -(1 - p)q_h B - \frac{(p(1 + pq_l) - 1)q_h}{\delta} \\ &= \frac{q_h}{\delta} (1 - p - pq_l - (1 - p)\delta B). \end{aligned}$$

Therefore, we obtain that $DB > DC$ only if $p(1 + q_l) < 1$ and $B < \frac{1 - p - pq_l}{(1 - p)\delta}$. ■

From the proof of proposition 3 we can see that the principal with flexible contract *ex ante* have a higher chance to have a competent agent for the second period production. But the principal may have a more severe incentive problem in this case. As we mentioned in subsection 3.2, the principal may have chances to fire a competent agent with bad luck. To replace him, the principal hires a new agent from the market. Although the new one has higher probability that he is competent, the principal needs to pay more to motivate him to exert effort. While in the exclusive relationship, the principal will never fire a competent agent with bad luck. In this case, she is stuck with the agent even if she knows that he is with low quality.

We can easily get the following result on the comparative statics with respect to the morale problem, measured by δ , which is also summarized by Table 2.

Corollary 1 *It is optimal for the principal to have a flexible relationship with information provision if the morale problem is big ($\delta \geq \frac{q_l}{(1-p)(1-q_h)B}$); a flexible relationship but no information provision if the morale problem is medium size ($\frac{1-p-pq_l}{(1-p)B} \leq \delta \leq \frac{q_l}{(1-p)(1-q_h)B}$); while an exclusive relationship with information provision if the morale problem is small ($\delta \leq \frac{1-p-pq_l}{(1-p)B}$).*

The comparative statics with respect to the sorting problem, measured by p , is much more complex. We know that $\pi_1 \geq \pi_2$ if $p \leq 1 - \frac{q_l}{(1-q_h)B\delta}$, and $\pi_2 \geq \pi_3$ if $p \leq \frac{1-B\delta}{1+q_l-B\delta}$. To get the full comparatives, we need to get the comparison between

Table 2: The relationship between the employment modes and the morale problem (measured by δ).

Morale problem	Employment Relationship	Information Structure
big	flexible	informed
medium	flexible	uninformed
small	exclusive	informed

π_1 and π_3 with respect to p . It is easy to get that $\pi_1 \geq \pi_3$ if $p \geq \frac{1}{B\delta}$. When p is large, which means that the principal has high probability that she hires an agent with good quality, the principal has less concern on efficiency. In this case, we can say that the sorting problem the principal faces is small. Otherwise, we say that the sorting problem is big. When the sorting problem is small, the efficiency concern is small; while the implicit incentive from career concern saves the principal's cost a lot. Hence, the flexible relationship with no information provision is preferred. As p decreases and the sorting problem increases, therefore efficiency concern increases and hence information provision is preferred. To conclude, we obtain the following results with respect to the sorting problem, which is summarized in Table 3.

Corollary 2 *It is optimal for the principal to have a flexible relationship but no information provision if p is large; a flexible relationship with information provision if p is of medium size; while an exclusive relationship with information provision if p is small.*

6 Extensions and Applications

6.1 A Possible Theory of the Firm

In this subsection, we apply the studies above to study the boundaries of the firm and provide a possible explanation about transaction costs for trading in different organizations. When the principal outsources product from the market, the principal

Table 3: The relationship between the employment modes and the sorting problem (measured by p).

Sorting Problem	Employment Relationship	Information Structure
small	flexible	uninformed
medium	flexible	informed
big	exclusive	informed

“are reluctant completely to disclose all internal accounting information to an outside party” (Riordan 1990). Contracts with another party in the market are often short term, easily canceled, and subject to renegotiation. When the principal organizes production in the firm, she needs to hire an agent/employee with a labor contract, which is always long term². As we can see from section 4, it is always beneficial for the principal to let the agent know precisely his ability.

We interpret π_3 as the profit for the principal if the production is organized in the firm and π_2 as the profit if the production is out-sourced. The difference between organizing the production in the firm and in the market is as follows: in the firm the agent finds it easier to access physical assets and colleagues so that he can get more precise information about his ability; while contracting in the market, the principal can easily switch to another agent in the market if she finds that the interacting agent is not efficient. Hence the cost to trade in the market is that the principal may switch from a competent agent with bad luck, and the cost for organizing in the firm is that the principal has less flexibility to fire the agent even if it turns out that the agent is with low ability.

Coase (1937) started the study of firm boundaries and raised the question of why we observed so much economic activity inside formal organizations if markets are such powerful and effective mechanisms for allocating scarce resources. Coase’s answer was in terms of the transaction costs in a world of imperfect information. If the transaction cost is large for the trade (outsourcing) in the market, it may be less

²One possible reason is due to the pressure of the labor union.

costly to organize production inside the firm than in the market.

From the proof of Proposition 3, we obtain the following result:

Proposition 4 *When $p(1 + q_l) < 1$ and $B < \frac{1-p-pq_l}{(1-p)\delta}$, it is beneficial for the principal to organize production in the firm; otherwise, it is better to outsource the production.*

When $p(1 + q_l) > 1$, the transaction cost for trading in the market is less than that in the firm and the gross gain is also larger in the market. Therefore, it is always beneficial for the principal to trade in the market and out-source the product. Contrarily, the transaction cost is larger in the market, organizing production inside the firm or in the market depends on the gain from successive effort B , the trade-off is as in the proposition.

To cope with the pressure from the Ministry of Education and promote the publications in SSCI cited journals, many economics departments of Chinese universities now trend to recruit doctoral graduates in Economics from over-sea universities by adopting a non tenured contract (out-sourcing). But tenure contract prevails for non over-sea graduates. When one university has a higher research level (valued by the number of SSCI publications by its faculties), it can get more financial support from the government. That is to say the output B (here, it is the publication in SSCI journals) is higher for the over-sea graduates than the domestic graduates. It is really hard for the domestic graduates to publish their research in SSCI journals in economics, which means high effort of the domestic graduates has small effect on the output (δ is small).

Even if the principal provides access to essential assets to the agent, the agent from outside still has many obstacles (for example, different culture or language) and may not fully understand them. Generally, firms have many business and are reluctant to disclose all internal information to an outside party for only one task. For the integrated firm, in practice, the inside agent has less obstacle to access and understand the essential assets and get useful information. Although the assumption of difference of information structure between organization forms is extreme, it captures the essence of the reality to a certain degree in the information aspect.

6.2 Project Investment

In this subsection, we assume that the principal can make an investment which affects the profitability of the employment. Depending on the nature of the labor market, the firms make different investment. Before offering the contract to the agent, the principal can make an investment which would affect the value of the project. The value of the project $B(I)$ satisfies the following properties: $B' > 0$, $B'' < 0$. The utility of the principal is equal to the profit she can get minus the investment: $\pi - I$. In the following, we call the agent who gets the extra information as an informed agent, and the one does not get any extra information as an ignorant agent.

If the principal decides to trade in the market and has the flexibility to switch to another agent, she can get

$$\pi^{FS} = \pi_1 = pq_h[(3-p)B(I) - \frac{2}{p\delta}]$$

with an informed agent and

$$\pi^{FI} = \pi_2 = pq_h[B(I)(2 + q_h - pq_h) - \frac{2 - pq_h}{p\delta} - 1]$$

with an ignorant agent, respectively. If she organizes production with a locked-in agent, she can get

$$\pi^{LS} = \pi_4 = 2pq_h B(I) - \frac{q_h}{\delta} \left(1 + \frac{1 - pq_h}{1 - q_h}\right)$$

with an informed agent and

$$\pi^{LI} = \pi_3 = 2pq_h B(I) - \frac{q_h}{\delta} (1 + p)$$

with an ignorant agent, respectively. Since $pq_h(3-p) > pq_h(2 + q_h - pq_h) > 2pq_h$, it is easy to get the following proposition:

Proposition 5 *The principal invests the least when trading with a locked in agent; and the most when trading in the market with an informed agent. That is to say, $I^{FS} > I^{FI} > I^{LS} = I^{LI}$ and therefore $B^{FS} > B^{FI} > B^{LS} = B^{LI}$.*

In Proposition 1, the value of the project when the agent is informed is the same as when the agent is ignorant. Now the value of the project when the agent is informed

is higher than when the agent is ignorant. Therefore, giving the principal flexibility to invest and choosing the value of project, the principal will be more inclined to the informed agent. Turning to Proposition 4 and taking into account the investment strategy, the principal's preference on the source of production would move towards outsource. Given the information structures of the agent, some projects may be "too good" to be selected.³

6.3 Robustness of Arm's Length Relationship

In the previous sections, we assume the principal's information structure is naturally given and analyze the principal's desire to have an ignorant agent. In this subsection, we change the setup a little bit and assume that the agent's information structure can not be changed or selected but the principal's can. To do this, we can investigate whether the result of the arm's length relationship (Cr mer 1995) is robust on the information structure of the agent. In the step of offering original contract, the principal can commit to choose different monitoring technology: efficient monitoring which enhance the principal to learn the agent's ability precisely (we call the principal in this case as an active principal) and inefficient monitoring with which the principal can only update her belief from observing performance by Bayesian rule (we call the principal in this case as a passive principal). Cr mer (1995) implicitly assumes that the agent is ignorant. When he studies the passive principal case, he says that "If first-period output is 0, the agent is fired" (Cr mer (1995), page 288).

When the agent is informed, the payoff of the active principal is the same as the payoff π_1 of the passive principal in equation (1). We summarize it as follows:

Proposition 6 *When the agent is informed, an active and a passive principal have the same payoff.*

When the agent is informed after one period and the principal knows that this agent is informed, the principal will offer a screening contract to sort the agent and motivate the agent with low ability to quit the firm voluntarily. Due to the assumption

³Similar problem is also studied by Ohlendorf and Schmitz (2011).

that the agent with low ability will never produce positive output, it is the same costly for the principal to screen the high ability agent and motivate him to exert high effort.

When the agent is ignorant,⁴ Crémer (1995) obtains the result as the following:

Proposition 7 [*Arm's Length Relationship (Crémer 1995)*] *When the agent is ignorant, an active principal has larger payoff than a passive principal if $B > \frac{q_l}{(1-p)(1-q_h)\delta}$.*

Remark: When a passive principal faces an informed agent at the beginning of the second period, the principal needs to solve a hidden type and hidden action problem. While in the active principal and ignorant agent case, the principal just need to face a hidden action problem. The cost in general should be higher in the previous case than in the latter case. The reason that the critical value of B in Proposition 1 and 7 are equal is due to the simplifying assumption for the production technology of the low ability agent.⁵ The results in these two propositions are qualitatively robust for richer settings.

The expected payoffs for the principal and expected net benefit the agent can get in all the four cases are summarized in Table 4 and Table 5 accordingly. From Table 4, one can see that if the principal cannot observe the type of the agent, she can get the same utility by letting the agent know his type. That is to say, it is indifferent for the principal between having the principal or the agent or both to know the type of the agent.

From Table 5, one can see that the agent always wants to get informed if it is costless and feasible. From Table 4, when the gain from good performance B is large enough, larger than $\frac{q_l}{(1-p)(1-q_h)\delta}$, the principal and the agent have the same willingness

⁴Prat (2005) uses a model of career concerns for experts to study whether it is beneficial for the principal to observe the agent's action. In his paper, the consequence of the agent's behavior depends on the state of the world and the agent's action. The agent can receive a private signal about the state of the world. This signal depends on the state of the world and the agent's type. Prat (2005) also assumes that the agent is ignorant and does not know his type.

⁵For example, we assume that the mis-matched agent can have a positive and very small probability $q_b < q_l$ to get success for the project which is independent of effort. The passive principal now needs to set up a contract menu to make sure that the bad agent would take leave voluntarily. Hence, the dismissal fee for the bad agent should be positive, $\frac{q_b}{\delta}$. Then the critical value is different.

Table 4: The principal's expected payoff

	Active Principal	Passive Principal
Informed Agent	$pq_h \left[(3-p)B - \frac{2}{p\delta} \right]$	$pq_h \left[(3-p)B - \frac{2}{p\delta} \right]$
Ignorant Agent	$pq_h \left[(3-p)B - \frac{2}{p\delta} \right]$	$pq_h \left[B(2+q_h - pq_h) - \frac{2-pq_h}{p\delta} - 1 \right]$

Table 5: The agent's expected net benefit

	Active Principal	Passive Principal
Informed Agent	$(1+p) \left(\frac{q_h}{\delta} - 1 \right)$	$(1+p) \left(\frac{q_h}{\delta} - 1 \right)$
Ignorant Agent	$(1+p) \left(\frac{q_h}{\delta} - 1 \right)$	$\frac{q_h}{\delta} - 1$

on the agent's information preciseness. Otherwise, they have conflict interest on the precision of the information the agent should have.

7 Concluding Remarks

In the principal-agent relationship, the information structure is usually assumed as exogenously given. But in many cases, the economic players can do something to change the information structures. For example, Williamson (1975) points out that replacing the external capital market by the "elite staff" through conglomeration (integration) can make the monitoring more efficient. Firms can also buy their inputs from markets instead of producing by themselves, which can limit the agent's information. In this paper, we study four different information structures in a unified two periods framework. We find that for the principal, her preference on the information structure depends on the employment relationship and the characteristics of the project and the labor market.

There are two possible and valuable directions for future research. When the principal cannot fire the agent, whether it is indifferent for the principal between having the principal herself or the agent to be informed needs further investigation.

The informed principal problem is not studied in this paper. If the bad agent also has a positive productivity and only the principal knows the matched ability of the agent, the principal may be better not to sort the agent in the second period and the informed principal problem arises. It would be worthwhile to explore it by enriching the settings of this paper in the future.

When career concern is a problem as when the principal can dismiss the agent whose performance in the first period is low, the agent always has incentive to become informed. When the value of the project is low, it is beneficial for the principal to have an ignorant agent. When the agent is locked in with the principal, career concern is not a question. Now the agent always likes to stay ignorant, while the principal prefers an informed agent. The agent's initiatives to become informed depends on the relationship (flexible or fixed) with the principal and is always conflict to the interest of the principal. This suggests that it is worthwhile to further study the trade-off in a more applied framework, such as second-sourcing, integration and so on. In a second sourcing framework, the agent will make himself informed if the principal commits to have a second source. The agent will have no incentive to become informed if the principal commits to sole source from this agent. Therefore, it is only beneficial for the principal to have a second source if the value of the project is large.

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