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Biased Motivation of Experts: Should They be Aggressive or Conservative? *

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Abstract

When we intend to hire a professional expert, which type of expert should we hire? Although it is sometimes claimed that decisions of experts tend to be conservative, is it optimal to choose a conservative expert? This paper attempts to answer these questions. It will show that a principal should hire a conservative expert, i.e., an expert who has biased preference for maintaining the *status quo*. The crucial aspect is that there is a possibility that the expert may not transmit truthful information. A neutral expert or an expert who has biased preference for implementing the project has a very strong incentive to recommend the project. Even when he/she cannot recognize whether the project is sufficiently productive, he may recommend the project. Hence, a conservative expert is considered to be beneficial for the principal.

Key words: Expert, Conservatism, Motivation,
JEL classification: D81, D82, D86, L23

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1 Introduction

—If you wish to obtain good advice, consult an old man—-old proverb.

When a decision maker has to evaluate a new risky investment, he/she may not have sufficient information about the evaluation. To obtain appropriate information, a decision maker often hires experts who have superior information and knowledge regarding the issue on which a decision is to be made. Doctors, lawyers, and consultants are examples of such experts. A doctor has superior information than a client, who has to make a decision. M&A advisors or consultants usually have special information, and they sell the information to their clients. Hence, information transmission from such experts is an important factor for decision making. Even within an organization, some types of experts prove to be useful. Managers lack sufficient information or knowledge to evaluate all potential projects, and they usually obtain information from experts within or outside the organization.

One big problem in hiring experts is that they may have private benefits or incentives in influencing the decision making process, and they may not transmit truthful information. In some cases, professional experts recommend highly conservative decisions. Li (2001) has pointed out, for example, that the Food and Drug Administration (FDA) of the United States has been criticized for its overcautiousness in approving new drugs. However, despite this criticism, the decisions of the FDA have not changed drastically. Can we justify the usage of recommendations from these conservative experts ? In general, if we recognize the possibility that experts have incentives for providing biased opinions, what type of experts should a decision maker hire? What is the optimal type of contract in such cases? This paper examines these problems, and we will show that a decision maker should hire an expert whose preference is biased toward maintaining the *status quo,* i.e., a "conservative" expert should be hired.

Biased incentives or motivations of experts have recently been pointed out by several papers. For example, Ottaviani and Sorensen (2006a) have shown that there are many situations in which professional experts tend to care about their future reputations. Other papers such as Ottaviani and Sorensen (2006b,2006c), Enrbeck and Waldmann(1996), Graham(1999) also examined about professional experts. They have shown that the preferences of professional advisors do not coincide with that of the decision makers. If experts care about their future reputations, the direct pecuniary payments from the principal are not the only incentives that affect the behaviors of experts. Prendergast (2007) focused on bureaucrats with a biased motivation. Although his main focus was on the biased preferences of bureaucrats, he has shown that biased motivations are quite popular.

To examine this problem more clearly, we consider the following example. A CEO has a potential project. An advisor is required to be hired to support the decision making process. Suppose there are two candidates — one young consultant and one senior consultant. Both of them have sufficient potential to evaluate the project, although both of them have to devote additional efforts to obtain sufficient information about the project. However, they have biased preferences. The young consultant has an opportunity to become the main advisor for the project, and thus, he has a private benefit in implementing the project. On the other hand, the senior consultant might loose his position if the project is implemented. This implies that the senior consultant has a private benefit in maintaining the *status quo,* since he already enjoy a good relationship with the CEO. In such a situation, should the CEO obtain advice from the young or the senior consultant?

One natural answer to this question would be as follows. When the effort level of an expert is unobservable to the decision maker, an incentive payment to the expert should be necessary. If the preference of the expert is biased toward implementing the project, the expert will devote his effort to realize the private benefit, and the decision maker can reduce the incentive payment. If this intuition is correct, a decision maker should hire an expert whose private benefit is biased toward implementing the project (we refer to this expert as an "aggressive" expert). In the above example, the CEO should hire the young consultant. We will show, however, that this intuition is incorrect. The decision maker should hire a "conservative" expert. The crucial aspect is that there is a possibility that the expert may not transmit true information. An aggressive expert has an incentive to recommend the project, even when he is unable to recognize whether the project is sufficiently productive. If an expert is conservative, however, he/she does not have such an incentive and recommends the project only when he/she got good signals actually. This is an intuitive reason as to why decision makers should hire conservative experts.

There are many papers that examine the problems in hiring experts. Most of the papers, however, have examined the situation in which there are no contractual arrangements. Krishna and Mogan (2001) have constructed, for example, a framework for the transmission of information from experts to a decision maker. They have employed the structure of Crawford and Sobel (1982), that is the “Strategic Information Transmission” mechanism. As Krishna and Mogan have clearly explained, in the setting mentioned by Crawford and Sobel (1982), a single expert with a biased preference cannot transmit truthful information. The intuitive reason is simple. If the contract arrangements do not exist and the preference of the expert is biased, there is no benefit for the expert to transmit truthful information. Hence, most papers that have employed the Crawford and Sobel model have considered cases with multiple experts. Li and Suen (2004) have examined the process of delegating decisions to biased experts. They have shown that the extreme but opposite biases are acceptable to a wide range of decision makers. Although these results have important implications for choosing biased experts, they did not consider the incentives for expert to gather information. Moreover, they do not consider the situation wherein the decision maker enters into a contract arrangements with the experts. In the context of political science, a setting without a contractual arrangement is natural, but professional experts usually make contract arrangements and receive pecuniary payments. Hence, it is natural to consider the situation wherein contracts arrangements exist.

In this perspective, this paper is mostly related to Gromb and Martimont (2007). They have considered contracted arrangements between a principal and experts and have derived optimal contracts. Their main subject is to derive the merits and demerits of hiring multiple experts. They have found that whether a principal should hire multiple experts is crucially dependent upon the possibility of collusion among experts. Although we will examine cases with multiple experts in the later section, our argument focuses on the biased experts. Thus, our results are very different from their results.[1]

In order to examine the "private incentives," it is important to distinguish the exogenously given incentives and the endogenously generated incentives. When the agent perceives private benefits that are independent of the pecuniary payment from the principal, the benefit may be exogenously given (intrinsic) or endogenously determined. In recent times, several papers have focused on the intrinsic biased preferences. For example, Prendergast (2007) examined the intrinsic biased motivation of bureaucrats. These intrinsic preferences are a typical example of the exogenously given preferences. Another

[1] Baliga and Sjöström (2001) examined biased experts with considering contract arrengements, However, they did not consider the incentives for experts to gather information. Morover, they mainly focused on the effects of peer review and it is much different from the main points of this paper.

example of the exogenously given preferences is reputation. As Ottaviani and Sorensen (2006a) have emphasized, reputation is one of the major incentive mechanisms for experts. Many papers have pointed out that financial analysts are highly concerned about their reputation. This process of reputation accumulation is not intrinsic and endogenously determined by the society; instead, it must be an exogenous variable for each principal. In this paper we focus on the exogenously given bias. We do not consider whether those preferences are intrinsically given or determined by the society. We assume that experts have biased preferences even without contracts.

On the other hand, several papers have examined endogenously generated biased incentives. For example, Li (2001) has pointed out that the Food and Drug Administration (FDA) of the United States is criticized for its overcautiousness in approving new drugs. The main argument of Li (2001) is group conservatism. He pointed out that the commitment to an *ex post* conservative decisions rule can encourage more effort for experimentation. Hence, a conservative decision is referred to as a generated decision rule in the paper. In this perspective, the argument of Li (2001) is related to the endogenously generated conservatism. The famous argument by Dewatripont and Tirole (1999) is another example of (endogenously) generated bias. They have shown that hiring "advocates", agents with generated biases, are good for a decision maker. Hence, our argument is different from that in those papers that have focused on the endogenously generated bias.

In section 2, we will present the basic model. In section 3, we extend this argument to the general setting, and in section 4, we consider cases with multiple experts. In section 5, we conclude our argument.

2 Model

In this section, we consider a situation in which a decision maker (principal) hires an expert (agent) to obtain information on the productivity of an investment. We assume that both of them are risk neutral. The principal has a risky investment project. The payoff of the project is $B > 0$ if it succeeds and $D < 0$ if it does not succeed. Without any advice from the expert, the knowledge of the principal is limited, and this project is too risky for him/her, i.e.,

$$qB + (1-q)D < 0 \tag{1}$$

where q is *a prior* probability of success. Moreover, we assume that the *status quo* payoff is 0. Hence, without information from the expert, the principal would not undertake the project and would choose to maintain the *status quo*.

To increase the probability of success, the principal hires an agent. The agent has to incur a private cost C to obtain appropriate information regarding the project. By incurring cost C, the agent obtains an appropriate signal with probability P, and he/she obtains nothing with probability $(1-P)$. Here, we assume that the signal improves the knowledge about the project and increases the probability of success from q to q^*. With regard to the signal, we can imagine another setting, for example, the signal would only provide more accurate information on the productivity of the project. If the project is actually productive, the agent tends to obtain a good signal, and he/she tends to obtain a bad signal if the project is not productive. Even if we assume such a situation, the argument of our paper is not affected, as will be proved in the appendix. Hence, we simply assume that the probability of success changes to $q^* > q$ on the basis of the appropriate signal.

We assume that this information gathering by the agent is efficient, i.e.,

$$P\{q^*B + (1-q^*)D\} - C \geq 0. \tag{2}$$

As long as the agent cannot obtain the appropriate signal, the project is not undertaken since the expected payoff of the project is negative. With probability $(1-P)$, the expected payoff becomes zero.

On the other hand, we assume that the agent has a biased preference for the project. If the project is not undertaken and the *status quo* is selected, the agent obtains a private benefit a. Hence, if we consider this private benefit for the judgment of social optimality, condition (2) becomes

$$P\{q^*B + (1-q^*)D\} - C \geq a. \tag{3}$$

However, we should note that this private benefit can be negative, which implies that there is a possibility that the agent is more biased toward undertaking the project. In the later section, we will explain in further detail about the significance of negative a.

2.1 Incentive of an expert

The expert provides an advice to the principal on whether the project should be undertaken ("go") or not ("stop"). A potential problem in this principal-agent relationship is that the principal has insufficient ability to judge the quality of information obtained from the agent. Hence, there are two types of incentive problems for the principal. First the agent may not pay the private cost C to obtain appropriate information, and second, the agent may not transfer authentic information. The principal offers a contract to the agent in order to solve these incentive problems and obtain appropriate information. The contract depends upon the following three possible outcomes: The contract indicates that the principal pays (1)W^H, if the project is undertaken and successful; (2) W^L, if the project is undertaken and it fails; and (3)W^0, if the project is not undertaken and the *status quo* is maintained. The principal chooses these variables to control the incentive problem of the agent. Since the principal obtains information only from the expert, the project is undertaken only when the agent says "go" to the principal.

Next, we examine the incentive problem of the agent. First, the agent has to provide authentic information. Thus the following truth-telling condition should be satisfied.

$$q^* W^H + (1 - q^*) W^L \geq W^0 + a, \tag{4}$$

$$W^0 + a \geq q W^H + (1 - q) W^L. \tag{5}$$

The first condition (4) implies that when the agent has appropriate information, it is better for the agent to say "go." Since the agent has appropriate information, he/she can expect that the probability of success is q^*. On the other hand, the second condition (5) implies that if the agent does not have appropriate information, he/she says "stop." Since the agent does not have information, the agent's expected probability of success is q.

Another incentive problem is the following information gathering condition.

$$P\{q^* W^H + (1 - q^*) W^L\} + (1 - P)(W^0 + a) - C \geq W^0 + a, \tag{6}$$

$$P\{q^*W^H+(1-q^*)W^L\}+(1-P)(W^0+a)-C\geq qW^{H}+(1-q)W^L. \quad (7)$$

The left-hand sides of inequalities (6) and (7) represent the net expected payoff for the agent when he/she decides to pay the information gathering cost C. Without gathering information, the agent has two alternatives: he/she merely says "stop" honestly (inequality (6)) or proposes "go" (inequality (7)). The information gathering condition should be satisfied under both these situations, but (7) is redundant as long as (5) is satisfied. Hence, we omit inequality (7).

Moreover, inequality (6) can be rewritten as

$$q^*W^H+(1-q^*)W^L-C/P\geq W^0+a, \quad (8)$$

This implies that inequality (4) is always satisfied as long as inequality (8) is satisfied. Hence, only (5) and (8) are the necessary incentive conditions. Furthermore, we assume that the agent faces liquidity constraints, i.e., the principal cannot offer negative wage rates. Therefore, principal's problem is represented as follows.

$$\begin{array}{lc} & Min \;\; P\{q^*W^H+(1-q^*)W^L\}+(1-P)W^0 \\ s.t & W^0+a\geq qW^H+(1-q)W^L \\ & q^*W^H+(1-q^*)W^L-C/P\geq W^0+a \\ & P\{q^*W^H+(1-q^*)W^L\}+(1-P)(W^0+a)-C\geq 0 \\ & W^H\geq 0, W^L\geq 0, W^0\geq 0. \end{array}$$

The third constraint is the individual rationality condition. Here we assume that the outside opportunity of the agent is 0. This condition is always satisfied as long as other conditions are satisfied, even if a is negative. Hence, we omit the individual rationality condition hereafter. Moreover, we can easily prove that it is optimal for the principal to set $W^L=0$.

Lemma 1 *It is optimal for the principal to set $W^{L*}=0$.*
Proof. *Suppose W^{H*}, W^{L*}, W^{0*} are the optimal and $W^{L*}>0$. By changing to $W^L=0$ and $W^H=W^{H*}+\frac{1-q^*}{q^*}W^{L*}$,the left-hand side of the constraints*

are unaffected, but the right hand side of the first constraint should be decreased since

$qW^H + (1-q)W^L = qW^{H*} + \frac{q(1-q^*)}{q^*}W^{L*} < qW^{H*} + (1-q)W^{L*}$.

This implies that W^0 *can be smaller than* W^{0*}*. Hence, it is optimal to set* $W^{L*} = 0$*.* ■

Hence, the above problem can be rewritten as

$$
\begin{aligned}
&Min\ Pq^*W^H + (1-P)W^0 \\
&s.t. \qquad W^0 + a \geq qW^H && (9)\\
&\qquad\qquad q^*W^H - C/P \geq W^0 + a && (10)\\
&\qquad\qquad W^H \geq 0,\ W^0 \geq 0.
\end{aligned}
$$

First, we confirm the significance of negative a.

Lemma 2 *Negative* a *implies that the agent obtains a private benefit when the project is undertaken.*

Proof. If the agent receives a private benefit, b, when the project is undertaken, the incentive conditions become, $W^0 \geq qW^H + b$ and $q^*W^H + b - C/P \geq W^0$. These are just same as (9) and (10) with negative a. ■

By solving the above problem, we obtain the following optimal contract.

Proposition 1 *The optimal contract for the principal is*

$$
\begin{array}{llll}
W^{H*} = \frac{C}{P(q^*-q)}, & W^{L*} = 0, & W^{0*} = -a + \frac{qC}{P(q^*-q)}, & if \quad a \leq \frac{qC}{P(q^*-q)}. \\
W^{H*} = \frac{a}{q^*} + \frac{C}{Pq^*}, & W^{L*} = 0, & W^{0*} = 0, & if \quad a \geq \frac{qC}{P(q^*-q)}.
\end{array} \tag{11}
$$

Proof. *From (9) and (10), we obtain* $q^*W^H - \frac{C}{P} \geq qW^H$*, and this implies that* $W^H \geq \frac{C}{P(q^*-q)}$*. Moreover, from (9), we obtain* $W^0 \geq -a + \frac{qC}{P(q*-q)}$*. Hence as long as* $a \leq \frac{qC}{P(q^*-q)}$, $W^{H*} = \frac{C}{P(q^*-q)}$ *and* $W^{0*} = -a + \frac{qC}{P(q^*-q)}$*. However, if* $a \geq \frac{qC}{P(q^*-q)}$*, the condition* $W^0 \geq 0$ *is binding. Hence* $W^{0*} = 0$ *and* $W^{H*} = \frac{a}{q^*} + \frac{C}{Pq^*}$ *from (10).* ■

This proposition implies that as long as a is not very high, W^0, the wage for choosing the *status quo* should be positive. In other words, although the project is not undertaken, the expert should obtain some positive gains. An intuitive reason for this fact is obtained from the truth-telling condition (9). In order to derive an incentive to say "stop" when the agent is unable to obtain appropriate information, the principal must pay sufficient wages even if the project is not undertaken.

Another important point of this proposition is that W^{0*} is a decreasing function of a. Since W^{H*} is independent from a, it is better for the principal to choose an expert who has a larger a. In other words, the principal should choose an expert whose preference is biased toward not undertaking the project. This may be a counter-intuitive result. For the incentive of information gathering, a pro-project expert is naturally better since his private benefit enhances the information gathering incentive. The above result shows, however, that another incentive constraint is more important for an optimal contract. If the incentive for the expert is biased toward undertaking the project, he/she has an incentive to say "go" even without the appropriate information. In order to avoid this possibility, the principal should pay W^{0*} even if the project is not undertaken. If the expert is more pro-project (negative a), this payment W^{0*} becomes higher. Thus, a high value of a can decrease the total payment of the principal.

Proposition 2 *Optimal minimum payment for the principal, T^*, is as follows.*

$$T^* = \begin{cases} \frac{C}{q^*-q}(q^* + q\frac{1-P}{P}) - (1-P)a & \text{if} \quad a \leq \frac{qC}{P(q^*-q)} \\ aP + C & \text{if} \quad a \geq \frac{qC}{P(q^*-q)}. \end{cases} \tag{12}$$

Proof. From the definition of T^*, $T^* = Pq^*W^{H*} + (1-P)W^{0*}$. Hence, by inserting W^{H*} and $W^{0*}$to T^*, we obtain the result. ■

From proposition 2, we can understand that T^* is a decreasing function of a, as long as $a \leq \frac{qC}{P(q^*-q)}$. An intuitive reason is similar to that of Proposition 1. A higher a can realize lower W^{0*} and decreases T^*. From this result, we obtain the following result.

Proposition 3 *The principal should choose an expert whose a is $a^* = \frac{qC}{P(q^*-q)} > 0$.*

Proof. We can directly derive this from Proposition 2. ■

Since $a^* > 0$, this proposition implies that the principal should choose an expert whose preference is biased for not undertaking the project, i.e., a "conservative" expert. Moreover, from proposition 2, T^* is monotone decreasing in the range $a \leq 0$. Hence, when the potential set of experts that the principal can choose is only $a \leq 0$, i.e., if all experts are biased toward undertaking the project, the principal should choose $a = 0$, i.e., the most neutral experts.

From proposition 3, we can derive the following comparative statistics.

Proposition 4 $\partial a^*/\partial C > 0, \partial a^*/\partial P < 0, \partial a^*/\partial q^* < 0.$

Proof. We can directly derive this from $a^* = \frac{qC}{P(q^*-q)}$ ■

These comparative statistics show that the optimal a^* is decreased if an agent acquires a higher level of technology. This implies that it becomes better for the principal to hire a more neutral expert, if the information gathering technology of the experts is improved. We should note however, that the optimal a^* is always positive. Hence even if parameters C, P or q^* have changed drastically, the principal should choose an expert whose private benefit is biased toward not undertaking the project.

2.2 Generalization of the principal's decision

In the above examination, we have assumed that the principal always undertakes the project if the expert advises "go." In this subsection, we will show that this decision is optimal for the principal even if we consider more general decision rules. In order to examine the optimal strategy, we assume that the principal implements the project with probability $f(\leq 1)$ and with probability $(1 - f)$ if the project is not undertaken even when the expert recommends to undertake the project. The incentive condition (9) is represented as follows.

$$W^0 + a \geq fqW^H + (1 - f)(W^M + a), \tag{13}$$

where W^M denotes the wage rate when the expert says "go" but the principal does not implement the project. On the other hands, the incentive condition (10) becomes

$$fq^*W^H + (1-f)(W^M + a) \geq \frac{C}{P} + W^0 + a. \quad (14)$$

From these incentive conditions, we can derive that

$$\begin{aligned} W^{H*} &= \frac{C}{P(q^*-q)f} \\ W^{0*} &= \frac{qC}{P(q^*-q)} - fa \\ W^{M*} &= 0 \end{aligned}$$

Hence, we obtain the following results.

Proposition 5 *Let us assume the principal implements the project with probability f when the expert submits "go." It is optimal for the principal to choose $f^* = 1$ and $a^* = \frac{qC}{P(q^*-q)}$. Moreover, it is optimal for the principal to choose $f^* = 1$ even if a is exogenously given.*

Proof. As in the previous section, the optimal minimum payment T^* can be defined as follows.

$$T^* = P\{fq^*W^{H*} + (1-f)W^{M*}\} + (1-P)W^{0*}.$$

Hence if $a \leq \frac{qC}{P(q^*-q)f}$,

$$\begin{aligned} W^{H*} &= \frac{C}{P(q^*-q)f},\ W^{0*} = \frac{qC}{P(q^*-q)} - fa,\ W^{M*} = 0. \\ T^* &= \frac{q^*}{q^*-q}C + \frac{1-P}{P}\frac{q}{q^*-q}C - f(1-P)a. \end{aligned}$$

On the other hand, if $a > \frac{qC}{P(q^*-q)f}$,

$$\begin{aligned} W^{H*} &= \frac{1}{fq^*}(\frac{C}{P} + fa), W^{0*} = 0, W^{M*} = 0. \\ T^* &= Pfq^*\frac{1}{fq^*}(\frac{C}{P} + fa) = C + fPa. \end{aligned}$$

These results show that T^* is a decreasing function of a when $a \leq \frac{qC}{P(q^*-q)f}$, and an increasing function of a when $a > \frac{qC}{P(q^*-q)f}$. It follows that for any f, T^* is minimized when $a = \frac{qC}{P(q^*-q)f}$ and T^* becomes $\frac{q^*}{q^*-q}C$. On the other hand, the principal maximizes

$$PfV - T^*,$$

where $V = q^*B + (1-q^*)D$. Thus, it is optimal for the principal to set

$$a^* = \frac{qC}{P(q^* - q)f} \text{ and } f^* = 1.$$

Therefore, the maximized net profit becomes

$$PV - \frac{q^*}{q^* - q}C.$$

Next, consider the case in which a is exogenously given. As long as $a \leq a^*$, T^* is a decreasing function of f. Hence, $PfV - T^*$ is maximized at $f = 1$. On the other hand, T^*becomes an increasing function of f if $a > a^*$. Even in this case, however,

$$PfV - T^* = Pf(V - a) - C,$$

and from (3), $V > a$. Thus, $PfV - T^*$ is maximized at $f = 1$ even in this case. ■

3 Private benefit from the success

In the previous section, we have assumed that an expert obtains his/her private benefit when the *status quo* is chosen (conservative expert) or the project is undertaken (aggressive expert). In this section, we will examine the case in which the expert obtains his/her private benefit, b, only when the project has succeeded. In this case, an expert obtains benefit $W^H + b$ when the project is implemented and successful, and obtains W^0 when the project is not implemented. Thus, the problem for the decision maker is presented as follows.

$$
\begin{aligned}
Min \quad & Pq^*W^H + (1-P)W^0 \\
s.t. \quad & W^0 \geq q(W^H + b) \\
& q^*(W^H + b) - \frac{C}{P} \geq W^0 \\
& W^H \geq 0, W^0 \geq 0.
\end{aligned}
$$

By solving this problem, we obtain the following proposition.

Proposition 6 *When an expert obtains his/her private benefit, b, for the success of the project, the optimal minimum payment for principal T^* is as follows.*

$$
T^* = \begin{cases} \frac{q^*}{q^*-q}C + \frac{q}{q^*-q}\frac{1-P}{P}C - Pq^*b & if \quad b \leq \frac{C}{P(q^*-q)} \\ (1-P)qb & if \quad b > \frac{C}{P(q^*-q)}. \end{cases}
$$

Proof. From the first and second constraints, we obtain $q^*(W^H + b) - \frac{C}{P} \geq q(W^H + b)$. This can be rewritten as $W^H + b \geq \frac{C}{P(q^*-q)}$. Therefore, if $b \leq \frac{C}{P(q^*-q)}$, $W^{H*} = \frac{C}{P(q^*-q)} - b$ and $W^{0*} = \frac{qC}{P(q^*-q)}$. This implies that $T^* = Pq^*W^{H*} + (1-P)W^{0*} = \frac{q^*}{q^*-q}C + \frac{q}{q^*-q}\frac{1-P}{P}C - Pq^*b$. On the other hand, if $b > \frac{C}{P(q^*-q)}$, $W^{H*} = 0$ and $W^{0*} = qb$. Thus, $T^* = Pq^*W^{H*} + (1-P)W^{0*} = (1-P)qb$. ■

In this situation, the private benefit, b, is a perfect substitute to W^H, and only $b + W^H$ is important for the incentive problem of the agent. Thus, the total payment for the principal, T^*, is a decreasing function of b unless b is sufficiently high to generate an incentive for the agent. If the private benefit b increases, the wage rate W^H can be decreased to equal b. This is the reason why T^* is a decreasing function of b.

Another important implication of this result is that the minimum payment T^* is not always a decreasing function of b, that is, a sufficiently high b is unbeneficial for the decision maker. Since b is a perfect substitute for W^H, one natural intuition is that if the private benefit b is very high, the decision maker does not have to pay the incentive payments. The above result shows, however, that this intuition is not true. If the private benefit b becomes very high, the expert has an incentive to say "go" even without obtaining appropriate information. In order to reduce the incentive, the decision maker has to increase W^0 when the private benefit b increases. Hence, choosing a very high b is not a good strategy for the decision maker.

The next question is whether the decision maker should hire a conservative expert or a success-oriented expert? We get the following result.

Proposition 7 *If a decision maker can choose any type of expert, he should choose a conservative expert as long as* $\frac{1-P}{P} > \frac{q^*}{q}$.

Proof. When a decision maker hires a success-oriented expert, T^* is minimized at $b = \frac{C}{P(q^*-q)}$ and it becomes $\frac{1-P}{P}\frac{q}{q^*-q}C$. On the other hand, if he/she hires a conservative expert, T^* is minimized at $a = \frac{qC}{P(q^*-q)f}$, and it becomes $\frac{q^*}{q^*-q}C$. Hence, the decision maker should hire a conservative expert (whose private benefit is $a = \frac{qC}{P(q^*-q)f}$) if $\frac{1-P}{P} > \frac{q^*}{q}$. ■

4 Multiple experts

In this section, we consider the situation in which a decision maker hires multiple experts. It may be natural to ask a multiple number of experts to obtain more precise information or more appropriate judgments. Even in the literature, many papers[2] have studied cases with multiple experts. Thus, examination about general properties of multiple experts is beyond the scope of this paper. In this section, instead, we only consider a simple case which is a natural extension of the single expert case. Intuitively, if a decision maker hires two experts, it may be natural to hire the two with contrasting preferences, i.e., one conservative expert and one aggressive expert. By hiring these experts, it seems that the decision maker can obtain more appropriate information. We will show, however, that there is a case wherein the decision maker should hire two conservative experts.

In order to examine this problem, we consider the following situation. Two experts attempt to obtain appropriate information for the project. They gather different types of essential information, and the probability of success

[2] For example, Gromb and Martimont (2007), Li (2000), Li and Suen (2001), Dewatripont and Tirole (1999), and Krishna and Morgan (2001)(2004).

depends on how many experts gathered the essential information. The probability of success becomes q^H if both of them obtain the information, and it becomes q^L if only one expert obtains the information. Here we assume that

$$q^H B + (1 - q^H) D > 0, \quad (15)$$
$$q^L B + (1 - q^L) D < 0, \quad (16)$$

that is, only when both of them obtain the appropriate information, the project becomes profitable. The private benefit of each expert is common knowledge, and the decision maker (principal) can hire any types of experts. Experts observe the essential information required for considering the project with probability P_i as long as he/she devotes sufficient efforts. We assume that $P = P_1 = P_2$, i.e., we focus on "symmetric" cases. There is a possibility that the two information gathering activities are correlated. With probability $P^H(\geq P)$, the expert j can obtain appropriate information if expert i obtains appropriate information. On the other hand, expert j obtains information with probability $P^L(\leq P)$ if expert i fails to obtain information. Obviously, $PP^H + (1-P)P^L = P$.

The timing of this game is as follows. First, the decision maker (principal) chooses two experts (i.e., a_1 and a_2) and offers wage contracts W_1 and W_2 to them,respectively. Second, each agent chooses their effort level and (if possible) observes the essential information. Third, both the experts submit their recommendations to the principal, and the principal determines the final decision according to the information submitted by the experts. In this setting, the verifiable information is the final outcome of the project. Although the experts may provide details about the project, the submitted recommendation “go” or “stop” is not verifiable. Thus, the wage contract is only contingent on the outcome of the project. In other words, here, we assume the "outcome-based contracts."[3]

The wage function can be written as follows. (1)W_i^H, if the project is undertaken and succeeds; (2) W_i^L, if the project is undertaken and fails; and (3)W_i^0, if the project is not undertaken and the *status quo* is maintained.

The principal determines the final decision contingent upon the decisions submitted by the experts. The best strategy for the principal is to choose

[3] Gromb and Martimont (2007) has shown that outcome-based contracts are collusion-proof and report-based contracts are not. This is one justification for using the ontcome-based contracts.

"go" only if both the experts say "go." Since $q^L B + (1 - q^L) D < 0$, the principal chooses "stop" even though one of the experts says "go."

First, we examine the truth-telling condition of the experts. Suppose an expert obtains appropriate information. He expects that expert j also observes the good signal with probability P^H. Because of the strategy of the principal, only when both the experts submits "go" the project should be undertaken. Thus, if expert i submits "stop," the project is always not undertaken, and he/she obtains $W_i^0 + a_i$ with probability 1. On the other hand, if he/she submits "go," the project is undertaken when expert j submits "go" with probability P^H. Hence, the truth-telling condition becomes as follows.

$$P^H q^H W_i^H + (1 - P^H)(W_i^0 + a_i) \geq W_i^0 + a_i \tag{17}$$

On the other hand, if expert i is unable to obtain a good signal, he expects that expert j observes a good signal with probability P^L. If he submits "stop," the project is not undertaken with probability 1, but it will be undertaken with probability P^L if he submits "go." The probability of success is q^L; however, since expert i was unable to obtain a good signal and submit an advice "go" is ineffective for increasing the actual probability of success. Thus, the truth-telling condition becomes as follows.

$$W_i^0 + a_i \geq P^L q^L W_i^H + (1 - P^L)(W_i^0 + a_i) \tag{18}$$

Next, we examine the incentive condition for devoting sufficient effort. Without devoting his/her effort, an expert has two options, say "go" or say "stop." Even if he/she submits such false information, the other agent may obtain appropriate information, and the project may be implemented. Thus, the following two incentive conditions must be satisfied.

$$P\{P^H q^H W_i^H + (1-P^H)(W_i^0 + a_i)\} + (1-P)(W_i^0 + a_i) - C \geq P q^L W_i^H + (1-P)(W_i^0 + a_i), \tag{19}$$

$$P\{P^H q^H W_i^H + (1-P^H)(W_i^0 + a_i)\} + (1-P)(W_i^0 + a_i) - C \geq W_i^0 + a_i, \tag{20}$$

The first condition (19) is the case in which the expert always says "go" although he/she does not devote any effort at all. Since with probability P, the other expert obtains appropriate information and says "go," he/she has a chance to obtain W_i^H with probability Pq^L. With probability $(1-P)$, however, the other expert does not obtain information, and the project is not undertaken. The second condition (20) is the case in which the expert always says "stop" when he/she does not devote any effort. Since the project is undertaken only when two experts say "go," the project does not realized with probability 1.

(17) and (18) can be rewritten as,

$$\begin{aligned} q^H W_i^H &\geq W_i^0 + a_i, \\ W_i^0 + a_i &\geq q^L W_i^H, \end{aligned}$$

(19) and (20) can be rewritten as

$$P^H q^H W_i^H + (1 - P^H)(W_i^0 + a_i) - C/P \geq q^L W^H,$$

$$P^H q^H W_i^H + (1 - P^H)(W_i^0 + a_i) - C/P \geq W_i^0 + a_i,$$

From these conditions, we can easily show that when (18) and (20) are satisfied, (19) is automatically satisfied. Furthermore, (20) implies

$$q^H W^H \geq \frac{C}{P^H P} + W_i^0 + a_i,$$

and it follows that (17) is redundant. In summary, (18) and (20) represent the constraints for the principal. Thus, the maximization problem of the principal becomes as follows.

$$\begin{aligned} &Min\ P\{P^H q^H (W_1^H + W_2^H) + (1 - P^H)(W_1^0 + W_2^0)\} + (1 - P)(W_1^0 + W_2^0) \\ &s.t. \qquad W_i^0 + a_i \geq q^L W_i^H \qquad i = 1, 2 \\ &\qquad\qquad q^H W_i^H \geq \frac{C}{P^H P} + W_i^0 + a_i \qquad i = 1, 2 \\ &\qquad\qquad W_i^0 \geq 0, W_i^H \geq 0. \end{aligned}$$

These constraints are quite similar to those in the one expert case. In fact, we obtain the following result,

$$q^H W_i^H = \frac{C}{P^H P} + q^L W_i^H,$$

as long as the first and second constraints are binding. Hence, we obtain the following optimal contracts.

$$\begin{aligned} W_1^{H*} &= W_2^{H*} = \frac{C}{P^H P(q^H - q^L)}, \\ W_i^{0*} &= \frac{q^L C}{P^H P(q^H - q^L)} - a_i. \quad i = 1, 2. \end{aligned}$$

Then, we obtain the following proposition.

Proposition 8 *Even in the case of two experts, the principal should hire two conservative experts. The optimal experts are* $a_1^* = a_2^* = \frac{q^L C}{P^H P(q^H - q^L)} > 0$.

Proof. Since the principal minimizes $P\{P^H q^H (W_1^H + W_2^H) + (1 - P^H)(W_1^0 + W_2^0)\} + (1 - P)(W_1^0 + W_2^0)$, he/she should hire experts who can minimize W_i^{0*} and W_i^{H*}. As long as the constraint $W_i^0 \geq 0$ is not binding, the principal should set $q^H W_i^H = \frac{C}{P^H P} + q^L W_i^H$ from the incentive constraints, and the contract should be $W_i^{H*} = \frac{C}{P^H P(q^H - q^L)}, W_i^{0*} = \frac{q^L C}{P^H P(q^H - q^L)} - a_i$. Hence if $a_i \leq \frac{q^L C}{P^H P(q^H - q^L)}$, the optimal contract for expert i is $W_1^{H*} = \frac{C}{P^H P(q^H - q^L)}$, $W_1^{L*} = 0$, and $W_i^{0*} = \frac{q^L C}{P^H P(q^H - q^L)} - a_i \quad for\ i = 1, 2$. On the other hand, if $a_i \geq \frac{q^L C}{P^H P(q^H - q^L)}$, the constraint $W_i^0 \geq 0$ must be binding, and $W_i^{H*} \geq \frac{C}{P^H P q^H} + \frac{a_i}{q^H}$, $W_i^{L*} = 0$, and $W_i^{0*} = 0$. These results show that the payments are minimized when $a_1^* = a_2^* = \frac{q^L C}{P^H P(q^H - q^L)}$. ■

This result shows that the basic structure is unaffected although the principal must hire two experts. The principal should hire two conservative agents. Even if there are multiple agents, it is necessary to provide sufficient incentive to each one of them. In order to derive the truth-telling incentive even when an agent obtains no information, the principal should pay the positive wage for not implementing the project. If each agent has a biased preference toward maintaining the *status quo,* the principal can decrease the incentive payment even if there are multiple agents.

5 Conclusion

We have shown that the principal should hire a conservative expert, i.e., an expert who has a biased preference for maintaining the *status quo,* if the principal can offer contract arrangements. By hiring the conservative expert, the principal can minimize the expected payment to the agent and can derive truthful information. This result is very different from the previous arguments that have assumed that there are no contract arrangements between the principal and an agent. An intuitive reason of our argument is simple. If an agent has a private motivation for implementing the project, he has an incentive to recommend the project even if he cannot obtain sufficient information about the project. In order to control such incentive, the principal has to pay a high amount even when the project is not implemented. On the other hand, if the agent is conservative (biased toward maintaining the *status quo*), the principal is not required to pay so much when the project is not implemented. Even without such pecuniary incentive, the agent has an incentive to stop the project. Hence, it is better for the principal to hire a conservative expert. We have shown a case in which this property is not affected even if the principal hires multiple experts.

Lastly, we should argue the possibility that the preference of an agent is not perfectly observable to the principal. In the previous sections, we have assumed that the preference of the agent is common knowledge, and the principal can observe the biased preference of each agent. In some cases, however, the principal cannot observe the preference precisely. Even if the principal cannot observe the preference of an agent precisely, the main results of this paper are not affected. Suppose there two groups of experts. One group is aggressive, and the other group is conservative. The principal cannot observe the exact preference of each expert. Even in such a situation, the principal should choose an expert from the group of conservative experts since, from Proposition 2, we can easily see that the expected total payment is minimized by employing the group of conservative experts. Hence our argument can be applied to more general environments in which the preference of an agent is not perfectly observable.

A Appendix

In this appendix, we will show that the results obtained in section 2 are unaffected even if an expert is a passive receiver of an effective signal. As mentioned in section 2, we assume that an expert has to devote his/her effort with private cost C to obtain a signal. Even while devoting the effort, however, the agent obtains the signal with probability p and obtains nothing with probability $1-p$. This signal provides more accurate information on the productivity of the project. If the project is actually productive, the agent tends to obtain a good signal, g, i.e., $\Pr\{g \mid G\} = \lambda > 1/2$ and $\Pr\{g \mid B\} = (1-\lambda)$. On the other hand, if the project is not productive, the agent tends to obtain a bad signal, b, i.e., $\Pr\{b \mid B\} = \lambda > 1/2$ and $\Pr\{b \mid G\} = (1-\lambda)$. Hence, the conditional probability of success after observing the good signal g is $\frac{\lambda q}{\lambda q+(1-\lambda)(1-q)} = q^H > q$ and that after observing the bad signal b is $\frac{(1-\lambda)q}{(1-\lambda)q+\lambda(1-q)} = q^L < q$. Of course, $mq^H + (1-m)q^L = q$, where m denotes the probability that the received signal is good, i.e., $m = \lambda q + (1-\lambda)(1-q)$.

In this situation, the following truth-telling conditions should be satisfied. $q^H W^H + (1-q^H)W^L \geq W^0 + a$,

$$q^H W^H + (1-q^H)W^L \geq W^0 + a,$$

$$W^0 + a \geq qW^H + (1-q)W^L.$$
$$W^0 + a \geq q^L W^H + (1-q^L)W^L.$$

The first condition requires that the agent should say "go" when he/she observes the good signal. The second (third) condition requires that the agent should say "stop" when he/she observes nothing (bad signal). Of course, the third condition is always satisfied as long as the second condition is satisfied. Hence, we omit the third condition.

Next, the agent should satisfy the following information gathering conditions.

$$\begin{aligned}
&p\{mq^H W^H + m(1-q^H)W^L + (1-m)(W^0+a)\} \\
&\qquad +(1-p)(W^0+a) - C \geq W^0 + a, \\
&p\{mq^H W^H + m(1-q^H)W^L + (1-m)(W^0+a)\} \\
&\qquad +(1-p)(W^0+a) - C \geq qW^H + (1-q)W^L.
\end{aligned}$$

By redefining $pm = P$ and $q^H = q^*$, these conditions can be rewritten as

$$q^* W^H + (1-q^*)W^L \geq W^0 + a,$$

$$W^0 + a \geq qW^H + (1-q)W^L.$$

$$\begin{aligned} P\{q^* W^H + (1-q^*)W^L\} + (1-P)(W^0+a) - C &\geq W^0 + a, \\ P\{q^* W^H + (1-q^*)W^L\} + (1-P)(W^0+a) - C &\geq qW^H + (1-q)W^L. \end{aligned}$$

and these conditions are just same as those in section 2. Hence, we can conclude that the results in section 2 can be satisfied even in this case.

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