Project Choice and Harmful Monitoring

Marco A. Haan* Bart Los† Yohanes E. Riyanto‡

August 8, 2007

Abstract

This paper shows that there may be circumstances in which a principal prefers not to observe the project choice of an agent that acts on her behalf. The ability of the agent is private information. Projects differ with respect to the amount of risk. If the principal can observe the project choice of the agent, the latter will use that choice as a signal. In the separating equilibrium, an agent with high ability then chooses a project that is too risky. If more diffcult projects require more effort, there are two opposite effects. The shirking effect implies that the agent chooses a project that is too safe. The signaling effect implies that he chooses a project that is too risky. The net effect is ambiguous. We also discuss the implications of our model for promotion policies.

JEL Classification Codes: D82, G34, L23.

Keywords: Principal-Agent, Project Choice, Career Concerns, Signalling.

*Department of Economics, University of Groningen, P.O. Box 800, 9700 AV Groningen, The Netherlands. Phone: +31-50-3637327. Fax: +31-50-3637227. e-mail: m.a.haan@rug.nl.

†Department of Economics, University of Groningen, P.O. Box 800, 9700 AV Groningen, The Netherlands. Phone: +31-50-3637227. Fax: +31-50-3637227. e-mail: b.los@rug.nl.

‡Department of Economics, FASS, National University of Singapore, AS2 1Arts Link, Singapore 117570. e-mail: ecsrye@nus.edu.sg, Phone:+65-8746939, Fax: +65-7752646. The authors thank Pim Heijnen, Allard van der Made, Sander Onderstal, and Bastiaan Overvest for useful comments.

1 Introduction

Often, an agent has to choose and implement some project on behalf of a principal. The economic literature has studied such cases using the canonical principal-agent model. Yet, often, the interests of principal and agent may not be as opposed as that model suggests. For example, both a venture capitalist and an entrepreneur have an interest in implementing a profitable project. Also, both an economist and an economics department have an interest in having high-quality publications. In such cases, the long-term objectives of the principal and the agent are closely aligned. Yet, in the shorter run, the agent may also have an incentive to use its project choice to influence the principal's perception of the agent's ability. It is that issue that we study in this paper. We show that the principal may then prefer to remain ignorant of the project choice of the agent.

In a nutshell, the argument is as follows. Consider an agent that chooses and implements a project on behalf of a principal. Perceptions of his ability are important, for example since they influence the agent's future job opportunities, either inside or outside the firm. If that is the case, the agent has an incentive to try to impress the principal by undertaking difficult projects, and thereby signalling his ability. This is especially true if the outcome of the project is hard to monitor in the short term. By undertaking difficult projects, the agent gives the impression that he has high ability. In fact, the agent may even be inclined to undertake a project that is too difficult for him. Obviously, this would not be in the best interest of the principal. She would prefer that the agent implements a project that he can handle, rather than a project that is too difficult for him. Thus, in such a situation, the principal is better off if she does not know the difficulty of the project that the agent implements, so he is not able to impress her by his choice of project. Instead, he will then just go for the project that is more suited for his capabilities. The principal will thus be better of by remaining ignorant about the agent's project choice.

As noted, in our model, the interests of principal and agent are perfectly aligned in the sense that both have the same long-run objectives. We extend the model to allow for the agent's disutility of effort. In that case, the principal faces a trade-off. If the principal remains uninformed about the agent's project choice, the agent will not choose a project that is too difficult. But he may then choose a project that is too easy, as easy projects require less effort. We thus have a trade-off between signalling and shirking.

Our model applies to situations in which workers have a high discretion to implement their own projects. Knowledge workers are a good example. For instance, consider the case of a young economist who contemplates a suitable outlet for his work. First suppose that his department will only be able to observe his actual publication record. The choice of journal will then be a trade-off between the probability of acceptance and the quality of the journal. The interests of the economist and his department are perfectly aligned. But now consider the case in which the department can also observe where this economist submits his paper. In that case, he will be inclined to send his paper to a better journal than he otherwise would, in an attempt to signal that his quality is higher than it really is.

As a second example, consider a firm that consists of a number of departments. The manager of each department proposes and implements a risky project. The probability that a project is successful, depends on the unobservable quality of a manager. The renumeration and career opportunities of a manager implicitly depend on his perceived ability. When the executive board can only observe whether or not a project has been implemented and the interests of the firm as a whole and each individual manager are perfectly aligned, then the manager will choose the project that maximizes expected profits. But when the executive board can also observe the nature of the project that is implemented, a manager will be inclined to implement a riskier project than he otherwise would, in an attempt to signal that his ability is high. Also in this case, even though the incentives of the individual and the group are perfectly aligned, the desire to signal leads to a decision that is more risky than the first-best solution.

One interpretation of our model is that, if there is no conflict of interest between principal and agent, then promotions should be based on strict output criteria rather than on the discretion of the principal. With strict rules, the principal's impression of his agent does not play a role in a promotion decision. Effectively, the principal then commits not to let her impressions play a role - hence, costly signalling can be avoided. As the conflict of interest between principal and agent increases, discretion becomes a better basis for promotions. It will induce signalling, but in this case, this benefits the principal.

The remainder of the paper is organized as follows. We first discuss some related literature in section 2. Then, in section 3 describes the basic set-up of our benchmark model, in which the interests of principal and agent are perfectly aligned. In section 4, we solve that model. We show that the principal always prefers not to be able to monitor the agent's choice project– or at least, to commit not to let such an observation influence the agent's career. In section 5, we introduce a conflict of interest between principal and agent. Now, the principal prefers to monitor the agent's project choice when the conflict of interest is sufficiently large. Section 6 considers the case in which the principal can commit to her probability of monitoring. Finally, section 7 concludes.

2 Related Literature

THIS SECTION WILL CHANGE AND MOVE. Our paper is related to the literature on career concerns which shows that an agent has an incentive to influence a principal's belief about the agent's ability. Such an incentive will motivate the agent to work hard in the current period, thereby building his reputation as an able agent. With such a reputation, the agent is able to elicit higher future wage payment from the principal.[1]

The presence of career concerns significantly influences the nature of projects that will be implemented by an agent. Holmstrom and Ricart i Costa (1986) show that under some conditions career concerns may induce an agent to under-or-overinvest in projects. The agent may also propose wrong projects deliberately or refrain from proposing projects allto-

[1] See Holmstrom (1982 and 1999).

gether in an effort to maintain his good reputation. In their model, the agent's competence is initially uncertain, but overtime it can be inferred using the agent's past performance.

Zwiebel (1995) shows that career concerns may induce an agent to refrain from undertaking innovations that are risky, i.e. those that stochastically dominate the industry wide innovation standard. This is because when the agent implements such a standard and when a relative performance evaluation is employed by the principal, implementing non standard and riskier innovations will lead him to be evaluated less accurately than his peers who undertake industry-wide standard innovations. Hence, in this sense career concerns lead to overly conservatism in the selection of projects.

Hirschleifer and Thakor (1992) demonstrate that a manager (or an agent) may deliberately distort investment policy in favor of relatively safe projects in an attempt to build his reputation. In their model, the manager's ability and his project choices are private information. The manager's ability can only be inferred from the observed success or failure. Consequently, the manager has an incentive to choose projects that will be more likely to succeed. An essential assumption here is that project outcomes (success or failure) can be observed early by the principal.

Finally, Kanodia, Bushman and Dickhaut (1989) illustrates a situation in which a manager (an agent) might have an incentive to choose a suboptimal action in an attempt to hide his private information thereby keeping his good reputation intact. In particular, imagine a situation in which a manager, who initially has invested in a new production equipment, learns that a different equipment that could do the same thing as the existing equipment but at a lower cost is available. It might well be possible that in this situation a switching to this new equipment is warranted. However, the manager might refuse to do so out of fear that he will be perceived by the market as a low ability manager.

Our paper looks at essentially the same issue, i.e. the impact of career concerns (or reputation) on the agent's investment behavior. However, there are some significant differences between our paper and those related papers. First, our paper is static in nature in the sense that it considers only a single project cycle, while those papers are dynamic in nature as they consider multiple project cycles. In our paper, projects have long gestation period and thus their outcomes can only be realized at some terminal date. The principal forms her posterior belief about the agent's ability upon observing the agent's project choice. Thus, here the project choice acts as a signal of the agent's ability. In those related papers, the principal is able to observe the project outcomes at some interim date. Upon observing these interim outcomes, the principal forms their belief about the agent's ability. Thus, in this sense the source of inference is not the project choice but the outcomes of the chosen project.

Second, contrary to those related papers, our paper endogenizes the decision of the principal to whether or not observe the difficulty nature of the projects. The ability of the principal to observe the difficulty nature of the projects stimulate the agent to use the project choice as a signal of ability. Thus, in this sense the principal can choose whether or not to allow 'communication' between the agent and herself to take place. In this respect, our paper is related to a recent paper by Friebel and Raith (2004). In that paper, they show that when the principal allows the agent to communicate, the agent will try to convince the principal that he is better suited for the supervisory role than the incumbent supervisor. As a result the incumbent may refrain from developing the agent's skills and expertise and also may deliberately recruit agents with low abilities. Consequently, in some situations it may be better for the principal to disallow the agent to directly communicate with her.

3 The Benchmark Model

An agent has the authority to choose some project to implement on behalf of a principal. A continuum of projects is available. Some projects are more risky than others, in the following sense. Riskier projects have a lower probability of success but, if successful, they also yield a higher return. The probability of success of any project will also depend on the ability of the agent. The higher the ability of the agent, the higher the probability of success of any given project.

The easiest way to capture these assumptions is as follows. The continuum of available projects is indexed by x, with $x \in [0, \bar{x}]$. Projects are identical in terms of their required effort. If project x is successful, it will yield the principal a payoff x. If it fails, it will yield payoff 0. The probability that it is successful, is $\theta - x$, with θ the ability of the agent. Thus, a higher ability agent has a higher probability of success in implementing any project. Also, for given θ, projects that have a higher payoff when successful, also have a lower probability of success, and hence are riskier. The expected return on project x is denoted as $R(x)$, so we have

$$R(x) = (\theta - x)\, x. \tag{1}$$

For simplicity, we assume that the ability of the agent is either high or low: θ_H or θ_L, respectively. The true ability is private information. A priori, the probability of a high type is ρ. The choice of project x thus serves as a signal of the agent's true ability. We denote the posterior belief of facing a high type as μ. We assume that $\bar{x} < \theta_L < \theta_H < 1$, so probabilities are always strictly between 0 and 1.

We assume that the payoff of the agent is based on two components. The first is the expected return of the project. There may be several reasons for this. For instance, the agent may have some intrinsic satisfaction of obtaining a higher expected return. Also, in the long run, the agent may get a renumeration that is based on the return of the project. The second component is the utility drawn from the perception that others have of his ability. A higher perception of those abilities may for example imply better job opportunities, either inside or outside the current relationship. When internal job opportunities are important, the agent will primarily care about the principal's perception. When external job opportunities are important, he will primarily care about the perception of outsiders. For our purposes, this is immaterial. Therefore, in the remainder, we will refer to the party that forms the relevant perceptions as the receiver in this game. As an illustration, consider the venture capital example from the introduction. If the venture capitalist has a higher perception of the entrepreneur's ability, then the entrepreneur has a better chance of obtaining financing in the first place. At the same time, the entrepeneur also has an incentive to choose a project with a high expected return: if he does obtain financing, then such a project will also give him higher expected monetary rewards.

Expected payoffs for the agent of choosing project x can be denoted as:

$$B_A = \alpha\left(\theta - x\right)x + f\left(\mu\right), \tag{2}$$

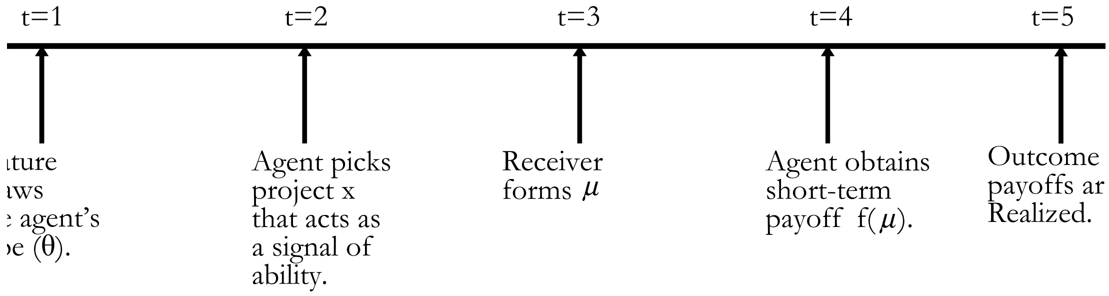
where the parameter α measures the relative importance of the expected return of the project, μ is the receiver's posterior belief regarding the agent's type, and f is an increasing function: the agent is better off the higher the receiver's posterior be of him being a high type. Expected payoffs for the principal are simply

$$B_P = \left(\theta - x\right)x \tag{3}$$

In our venture capital example, this would suggest that the venture capitalist obtains all revenues from the project. This, however, is immaterial. The only thing we need for our analysis is that the venture capitalist's return is proportional to the return on the project. We may just as well use $B_P = \lambda\left(\theta - x\right)x$, with any $\lambda > 0$. Something similar is true for the payoffs of the agent, B_A: we may just as wel have $B_A = \kappa\left(\alpha\left(\theta - x\right)x + f\left(\tilde{\theta}\right)\right)$, with any $\kappa > 0$. Note that this also implies that the choice of the scaling factor α is innocuous.

Our model can be summarized by the time line depicted in Figure 1. In the next section, we solve the model using backward induction.

line



1.pdf

Figure 1: The Time Line

4 Solving the benchmark model.

In this section, we solve the model we set out above. In section 4.1 we consider the case in which the project choice is unobservable. Section 4.2 solves the model when the project choice is observable. Section 4.3 compares the two cases.

4.1 Unobservable Project Choice

Suppose that the agent's choice of project is unobservable. In that case, the agent's choice cannot influence the receiver's perception of his ability, hence $\mu = \rho$. The agent then chooses

$$x_i = \arg\max_x \alpha (\theta_i - x) x + f(\rho),$$

which is maximized by setting

$$x_i = \theta_i/2, \ i \in \{L, H\}. \tag{4}$$

Note that the project chosen by the agent is also the one that is preferred by the principal, in the sense that it maximizes B_P. In the remainder of the paper, we will refer to the first-best project of type i as x_i^{fa}, with $i \in \{L, H\}$. Thus, in this model, we have $x_i^{fa} = \theta_i/2$. Similarly, we will refer to the first-best of the principal facing a type i agent as x_i^{fp}. Hence, we here have $x_i^{fp} = \theta_i/2$. In this case, we thus have $x_i^{fa} = x_i^{fp}$. This, however, is no longer the case once we introduce a conflict of interest.

4.2 Observable Project Choice

If the principal can observe the agent's choice of project, we have a signalling model. We first define our equilibrium concept:

Definition 1 *A sequential equilibrium of the game described above consists of a strategy x_L^* for the low type, a strategy x_H^* for the high type, and a system of beliefs $\mu(x)$ such that the following conditions hold:*

1. *Optimality for the agent; For $i = L, H$,*

$$x_i^* \in \arg\max_x \alpha\left(\theta_i - x\right)x + f\left(\mu(x)\right) \tag{5}$$

2. *Bayes' consistency of beliefs;*

$$\mu(x) = \begin{cases} 1 & \text{if } \; x = x_H^* \neq x_L^* \\ \rho & \text{if } \; x = x_H^* = x_L^* \\ 0 & \text{if } \; x = x_L^* \neq x_H^* \\ \in [0,1] & \text{otherwise} \end{cases} \tag{6}$$

We first introduce some additional notation. The ability difference of the high type and the low type is denoted $\Delta_\theta \equiv \theta_H - \theta_L$. We write f_L for the perception payoffs of an agent that is known to be a low type, and f_H for those of an agent known to be a high type: $f_L \equiv f(0)$, $f_H \equiv f(1)$. The difference between the two is $\Delta_f \equiv f_H - f_L$.

As usual, we assume that the problem is not trivial, in the sense that $(x_L^*, x_H^*) = (x_L^{fa}, x_H^{fa})$ is not a sequential equilibrium. In other words; we assume that when a type H would set x_H^{fa} in equilibrium, a type L would have an incentive to mimic that strategy. Hence, there is a scope for signalling. We take advantage of the arbitrariness of out-of-equilibrium beliefs to assume that an out-of-equilibrium message is interpreted as being sent by a low type: $\mu(x) = 0$ for $x \neq x_H^*$. We can then show:

Theorem 1 *The unique separating equilibrium surviving the Intuitive Criterion has*

$$(x_L^*, x_H^*) = \left(x_L^{fa}, \frac{\theta_L}{2} + \sqrt{\frac{\Delta_f}{\alpha}}\right) \tag{7}$$

Proof. With the usual arguments, the low type will implement his first-best project in any separating equilibrium, so $x_L^* = x_L^{fa} = \theta_L/2$. Also, we need that x_H^* is such that type L is just not willing to mimic the high type and being perceived as having high ability. Thus

$$\alpha \left(\theta_L/2\right)^2 + f_L \geq \alpha \left(\theta_L - x_H^*\right) x_H^* + f_H,$$

or

$$x_H^* \geq \frac{\theta_L}{2} + \frac{1}{\sqrt{\alpha}}\sqrt{\Delta_f}. \tag{8}$$

If the high type chooses to defect, his best possible defection is x_H^{fa}. Incentive compatibility for the high type thus requires

$$\alpha \left(\theta_H - x_H^*\right) x_H^* + f_H \geq \alpha \left(\theta_H/2\right)^2 + f_L,$$

or

$$x_H^* \leq \frac{\theta_H}{2} + \frac{1}{\sqrt{\alpha}}\sqrt{\Delta_f}.$$

With $\theta_H > \theta_L$, this upper bound on x_H^* is always higher than the lower bound given by (8). Therefore, a separating equilibrium always exists. With the usual arguments, the unique equilibrium surviving Cho and Kreps (1987) Intuitive Criterion has (8) binding for the high ability type[2], which establishes the result. ■

For this analysis to be valid, we need two additional conditions. First, note that we assumed that (x_L^{fa}, x_H^{fa}) is not a sequential equilibrium. Hence we need $x_H^* > x_H^{fa}$, so

$$\sqrt{\Delta_f} > \frac{1}{2}\sqrt{\alpha}\Delta\theta. \tag{9}$$

[2]Note that one can also show that there exist pooling equilibria. However, in this paper we focus out attention on the more interesting case, that is the separating equilibrium case. Furthermore, pooling equilibria will not survive the Cho-Kreps intuitive-criterion' equilibrium refinement.

Second, note that it is not feasible to have $x \geq 1$. Hence we need $x_H^* < 1$ or

$$\sqrt{\Delta_f} < \frac{1}{2}\sqrt{\alpha}\left(2 - \theta_L\right).$$

Combining inequalities yields

Assumption 1 $\frac{1}{2}\sqrt{\alpha}\Delta\theta \leq \sqrt{\Delta_f} \leq \frac{1}{2}\sqrt{\alpha}\left(2 - \theta_L\right).$

4.3 Comparing the two regimes

From the analyses above, we thus have that in the equilibrium of our benchmark model, the high type chooses a project that is riskier than his first-best choice. This is also not in the best interest of the principal. The project choice of the low type is unaffected. Both in the case where his project choice is observable, and in the case where it is not, he chooses to set his first-best project. We therefore have:

Theorem 2 *In the benchmark model, the a priori expected payoffs of the principal are strictly higher when the project choice is unobservable.*

Proof. With unobservability, expected payoffs equal $(1-\rho)\,\theta_L^2/4 + \rho\theta_H^2/4$. With observability, they equal $(1-\rho)\left(\theta_H - x_L^*\right)x_L^* + \rho\left(\theta_H - x_H^*\right)x_H^*$. With $x_L^* = \theta_L/2$ and $x_H^* > \theta_H/2 = \arg\max_x \left(\theta_H - x\right)x$, we have the result. ■

Hence, in this case, the principal would like to commit not to be able to observe the project choice of the agent. In doing so, she would avoid costly signalling by the high type, that ultimately is also costly for herself. There is a detrimental *signalling effect*, as we depict in Figure 2.

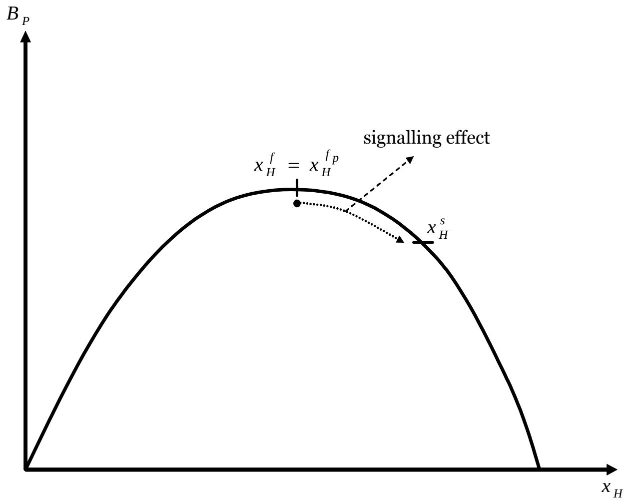


Figure 2: The Benchmark Case (No Conflict of Interest)

Of course, the principal may also try to avoid signaling by trying to make sure that (9) is not satisfied. One way to do so is to make Δ_f small. Note that Δ_f can be interpreted as the difference between the future benefits obtained by an agent that is known to be of high ability, and the future benefits obtained by an agent that is known to be of low ability. Interestingly, such an interpretation implies that distortive signalling can be avoided by having a policy of promoting personnel only on the basis of some objective measure of output, rather than on the basis of managerial discretion. With such a policy, the high ability type would not have an incentive to try to impress the principal, and hence would not engage in costly signalling.

5 Introducing a conflict of interest

5.1 The Model

We now introduce a conflict of interest between the principal and the agent. Suppose that the agent has to exert some effort in implementing a project and, more importantly, that that effort differs among projects. From our analysis with observable project choice we have that, ceteris paribus, an agent with higher ability chooses a riskier project. This suggests that riskier projects are harder to pull off. Hence, it seems natural to assume that such projects also require more effort. To capture this, we assume project x requires effort γx^2. For simplicity, we assume that this effort is independent of the quality of the agent. This does not affect our qualitative results, as we will show later. The agent's payoff now is

$$B_A = \alpha\left(\theta_i - x\right)x - \gamma x^2 + f(\mu),\ i \in \{L, H\}. \tag{10}$$

5.2 Solving the Model

First consider the case where project choice is observable. The agent then simply sets x_i to maximize (10) and will therefore choose

$$x_i^{fa} = \frac{\theta_i}{2}\frac{\alpha}{\alpha+\gamma},\ i \in \{L, H\}. \tag{11}$$

Note that $\alpha/(\alpha+\gamma)$ is strictly between 0 and 1. Hence, when x_i^{fa} is well-defined in the benchmark model, then it also is in this adapted model. The principal, however, still wants to maximize (3), and hence prefers to have

$$x_i^{fp} = \frac{\theta_i}{2},\ i \in \{L, H\}. \tag{12}$$

Thus we now have a conflict of interest between principal and agent, even in the case where project choice is observable. Similar to the standard principal-agent model, the principal wants the agent to exert more effort than the latter's first-best choice. We will refer to the difference between x_i^{fa} and x_i^{fp} as the *shirking effect.*

Now consider the case where project choice is unobservable. A sequential equilibrium now requires

$$x_i^* \in \arg\max_x \alpha\left(\theta_i - x\right)x - \gamma x^2 + f\left(\mu(x)\right),$$

while (6) is unaffected. This yields the following:

Theorem 3 *The unique separating equilibrium surviving the Intuitive Criterion has*

$$\left(x_L^*, x_H^*\right) = \left(x_L^{fa}, \frac{\theta_L}{2}\frac{\alpha}{\alpha+\gamma} + \frac{1}{\sqrt{\alpha+\gamma}}\sqrt{\Delta_f}.\right) \tag{13}$$

Proof. Again, obviously $x_L^* = x_L^{fa}$. Incentive compatibility for the low type now requires

$$\alpha\left(\theta_L - x_L^*\right)x_L^* - \gamma\left(x_L^*\right)^2 + f_L \geq \alpha\left(\theta_L - x_H^*\right)x_H^* - \gamma\left(x_H^*\right)^2 + f_H.$$

or

$$x_H^* \geq \frac{\theta_L}{2}\frac{\alpha}{\alpha+\gamma} + \frac{1}{\sqrt{\alpha+\gamma}}\sqrt{\Delta_f}. \tag{14}$$

Incentive compatibility for the high type now requires

$$\alpha\left(\theta_H - x_H^*\right)x_H^* - \gamma\left(x_H^*\right)^2 + f_H \geq \alpha\left(\theta_H - x_H^{fa}\right)x_H^{fa} - \gamma\left(x_H^{fa}\right)^2 + f_L,$$

or

$$x_H^* \leq \frac{\theta_H}{2}\frac{\alpha}{\alpha+\gamma} + \frac{1}{\sqrt{\alpha+\gamma}}\sqrt{\Delta_f}.$$

With $\theta_H > \theta_L$, this upper bound on x_H^* is always higher than the lower bound given by (20). Therefore, a separating equilibrium always exists. With the usual arguments, the unique equilibrium surviving Cho and Kreps (1987) Intuitive Criterion has (20) binding for the high ability type, which establishes the result. ■

Compared to the benchmark model, the absolute deviation relative to the first-best of the low type is now smaller. Choosing a project different from the first-best is now costlier than in the benchmark model, as it also implies an additional cost of effort. Hence, the high type does not have to distort as much as before to discourage the low type to mimic his choice.

Just as in the benchmark model, we again need to have $x_H^{fa} < x_H^* < 1$. Fortunately, the same parameter restrictions are sufficient to guarantee that in this model:

Result 1 *In the model with effort, assumption 1 is also sufficient to have* $x_H^{fa} < x_H^* < 1$.

Proof. The first inequality, $x_H^{fa} < x_H^*$, requires

$$\frac{\theta_H}{2}\frac{\alpha}{\alpha+\gamma} < \frac{\theta_L}{2}\frac{\alpha}{\alpha+\gamma} + \frac{1}{\sqrt{\alpha+\gamma}}\sqrt{\Delta_f}$$

or

$$\sqrt{\Delta_f} > \frac{\alpha\Delta_\theta}{2\sqrt{\alpha+\gamma}}, \tag{15}$$

The second inequality, $x_H^s < 1$, requires

$$\frac{\theta_L}{2}\frac{\alpha}{\alpha+\gamma} + \frac{1}{\sqrt{\alpha+\gamma}}\sqrt{\Delta_f} < 1 \tag{16}$$

or

$$\sqrt{f_H - f_L} < \frac{\frac{1}{2}\alpha\left(2-\theta_L\right)+\gamma}{\sqrt{\alpha+\gamma}}$$

Combining these inequalities, we need

$$\sqrt{f_H - f_L} \in \left(\frac{\alpha\Delta\theta}{2\sqrt{\alpha+\gamma}}, \frac{\frac{1}{2}\alpha\left(2-\theta_L\right)+\gamma}{\sqrt{\alpha+\gamma}}\right) \tag{17}$$

Note that

$$\frac{\partial}{\partial\gamma}\left(\frac{\alpha\Delta\theta}{2\sqrt{\alpha+\gamma}}\right) = \frac{-\alpha\Delta\theta}{4\left(\alpha+\gamma\right)^{\frac{3}{2}}} < 0$$

and

$$\frac{\partial}{\partial\gamma}\left(\frac{\frac{1}{2}\alpha\left(2-\theta_L\right)+\gamma}{\sqrt{\alpha+\gamma}}\right) = \frac{2\alpha+2\gamma+\alpha\theta_L}{4\left(\alpha+\gamma\right)^{3/2}} > 0.$$

Hence, the lower bound of (17) is decreasing in γ, while the upper bound is increasing in γ. This implies that if the condition is satisfied in the benchmark case, where effectively $\gamma = 0$, then it is also satisfied for any $\gamma > 0$. Hence, if assumption 1 is satisfied, then we also have $x_H^{fa} < x_H^* < 1$ in our model with effort. ■

5.3 Comparing the two regimes

For our benchmark model, we showed that the principal always prefers not to be able to observe the agent's project choice. In this section, we show that this may no longer be the case when a more risky choice also requires more effort. Again, a low type chooses the same project in both regimes, so we only have to consider the choice of a high type. With a high type, the first-best of the principle still is $x_H^{fp} = \theta_H/2$. Since her pay-off function is quadratic, the preference of the principal boils down to whether x_H^* or x_H^{fa} is closer to x_H^{fp}. For ease of exposition, we assume that the principal can choose whether or not to observe the actions of the agent. We thus add a stage at $t = 0$ in the time line in figure 1. Since it is now a deliberate choice of the principal whether or not to observe, we will refer to that decision as whether or not to *monitor* the agent's project choice. For simplicity, we assume that monitoring is costless. Provided that true monitoring costs are not too high, this assumption does not affect our qualitative results.

For the purposes of this section, it is convenient to define an upper bound on Δ_θ. Note that from assumption 1, we always have $\Delta_\theta \leq 2\sqrt{\Delta_f/\alpha}$. For any $\gamma \geq 0$, this immediately implies that $\Delta_\theta \leq \left(2\sqrt{\alpha+\gamma}\sqrt{\Delta_f}\right)/\alpha$. We will refer to the latter value as $\Delta_\theta^{\max}$.

We can now establish the following result:

Theorem 4 (Undersignalling) *If $\Delta_\theta > \Delta_\theta^{\max} - \gamma\theta_H/\alpha$, the principal chooses to monitor. If she does, however, the agent will still choose a project that is too safe from the principal's perspective.*

Proof. For the result to hold, we need $x_H^* < x_H^{fp}$, hence

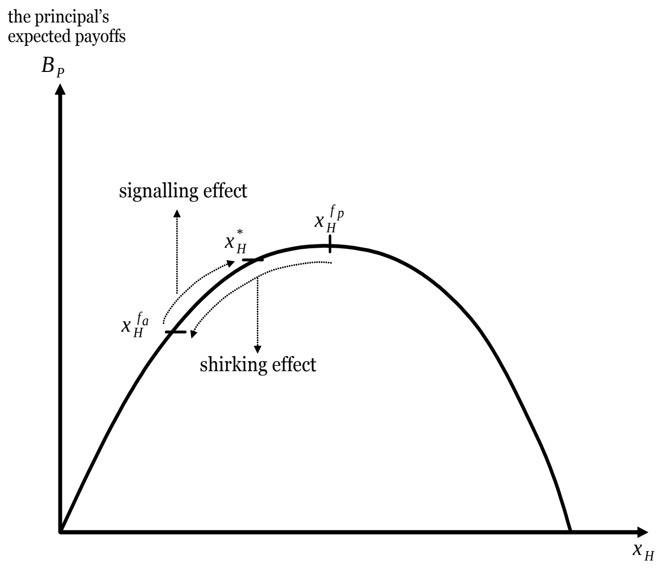
$$\frac{\theta_L}{2}\frac{\alpha}{\alpha+\gamma} + \frac{1}{\sqrt{\alpha+\gamma}}\sqrt{\Delta_f} < \theta_H/2,$$

which, using the definition of $\Delta_\theta^{\max}$, implies the condition stated in the theorem. ■

Essentially the result is driven by a trade-off between two effects. The first one is the *shirking effect*. Given that we have a conflict of interest, there will be a divergence between the principal's first best project choice x_H^{fp} and the high-type agent's first best project choice x_H^{fa}. The shirking effect represents the extent of this divergence. The second one is the *signalling effect.* In a separating equilibrium, a high type will have an incentive to separate himself from the low type by choosing a riskier project (a higher x_H^s) than he otherwise would. The incentive to signal will push back the agent's project choice closer to the principal's first best project choice. This is why in this case signalling will be beneficial for the principal. It implies that the principal prefers to be able to monitor the riskiness of the agent's project choice. This result can also be depicted in Figure 3. Note that, in this case, the signalling effect is not strong enough to fully compensate for the shirking effect. That is why we refer to this case as one of undersignalling.

signalling

1



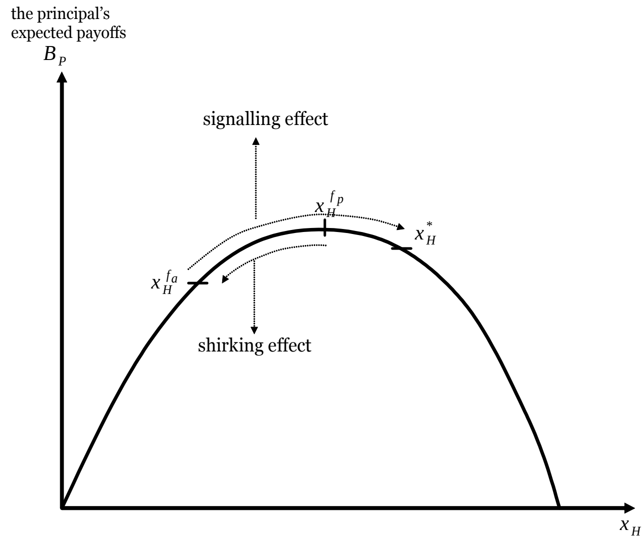
3.pdf

Figure 3: Undersignalling ($\Delta_\theta > \Delta_\theta^{\max} - \gamma\theta_H/\alpha$)

However, there may also be cases in which the signalling effect more than compensates for the shirking effect. But, also in that case, observing the project choice may still make the principal better off, as long as the project choice with observability is still closer to the principal's first best than the agent's first-best project. We refer to this case as one of oversignalling, and depict it in figure 4.

signalling

2



4.pdf

Figure 4: Oversignalling
($\Delta_\theta^{\max} - 2\gamma\theta_H/\alpha < \Delta_\theta < \Delta_\theta^{\max} - \gamma\theta_H/\alpha$)

Theorem 5 (Oversignalling) *If* $\Delta_\theta \in (\Delta_\theta^{\max} - 2\gamma\theta_H/\alpha, \Delta_\theta^{\max} - \gamma\theta_H/\alpha)$, *the principal chooses to monitor. If she does the agent will choose a project that is too risky from the principal's perspective.*

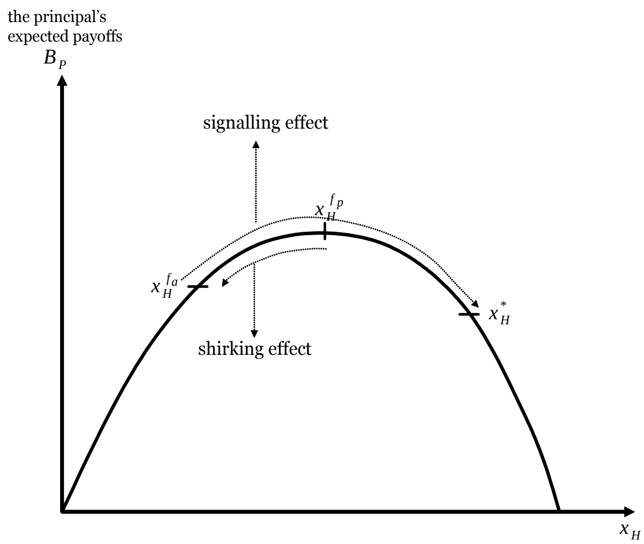
Proof. For the result to hold, two conditions need to be satisfied. First, we need $x_H^* > x_H^{fp}$: the project choice with observability is riskier than the principal's first-best. Second, we need $x_H^* - x_H^{fp} < x_H^{fp} - x_H^{fa}$: the project choice with observability is closer to the principal's first best than the project choice without observability. From the previous theorem, we have that the first condition is satisfied if $\Delta_\theta < \Delta_\theta^{\max} - \gamma\theta_H/\alpha$. The second condition implies

$$\frac{\theta_L}{2}\frac{\alpha}{\alpha+\gamma} + \frac{1}{\sqrt{\alpha+\gamma}}\sqrt{\Delta_f} - \frac{\theta_H}{2} < \frac{\theta_H}{2} - \frac{\theta_H}{2}\frac{\alpha}{\alpha+\gamma}.$$

or $\Delta_\theta > \Delta_\theta^{\max} - 2\gamma\theta_H/\alpha$. Combining the two establishes the result. ■

Finally, there may be cases in which the signalling effect is so strong that the net effect is to make the principal worse off if he can monitor. We depict this case in figure 5. Note that we also had this case in the previous section, where the shirking effect was zero.

signalling



5.pdf
Figure 5: Excessive signalling ($\Delta_\theta < \Delta_\theta^{\max} - 2\gamma\theta_H/\alpha$)

Theorem 6 (Excessive signalling) *If $\Delta_\theta < \Delta_\theta^{\max} - 2\gamma\theta_H/\alpha$, the principal chooses not to monitor. The agent chooses a project that is too safe from the principal's perspective.*

Proof. For the result to hold, two conditions need to be satisfied. First, we need $x_H^* > x_H^{fp}$: the project choice with observability is riskier than the principal's first-best. Second, we need $x_H^* - x_H^{fp} < x_H^{fp} - x_H^{fa}$: the project choice with observability is closer to the principal's first best than the project choice without observability. From the previous theorem, we have that the first condition is satisfied if $\Delta_\theta < \Delta_\theta^{\max} - \gamma\theta_H/\alpha$. The second condition implies

$$\frac{\theta_L}{2}\frac{\alpha}{\alpha+\gamma} + \frac{1}{\sqrt{\alpha+\gamma}}\sqrt{\Delta_f} - \frac{\theta_H}{2} < \frac{\theta_H}{2} - \frac{\theta_H}{2}\frac{\alpha}{\alpha+\gamma}.$$

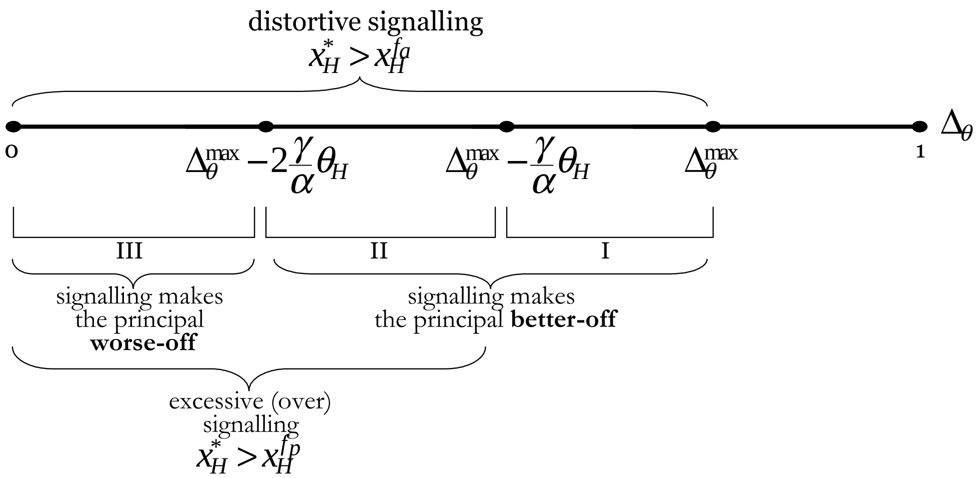
or $\Delta_\theta > \Delta_\theta^{\max} - 2\gamma\theta_H/\alpha$. Combining the two establishes the result. ■

Hence the principal chooses not to monitor the agent's project choice. With observability, she would have excessive signalling. Just like we had in the previous case, the agent's project choice is too risky from her point of view. However, in this case, the signalling effect is so excessive that it is better for the principal to avoid it altogether and settle for the agent's first-best choice.

The following figure illustrates the possible outcomes under observability. For given values of the other parameters, we have that for low Δ_θ, there is excessive signalling, for intermediate Δ_θ, there is oversignalling, and for high Δ_θ, there is undersignalling. Note that with $\Delta_\theta > \Delta_\theta^{\max}$, there would be no signalling. The intuition for this result is as follows. The shirking effect is independent of the ability difference between the two types. Yet, the closer the two types are in terms of ability, the more the high type has to signal in order to truly differentiate himself from the low type.

of

results



6.pdf

Figure 6: Summary of Results

Of course, it would also be interesting how a change in the extent of the conflict of interest would affect the result.

Theorem 7 *For given $\Delta_\theta \leq 2\sqrt{\Delta_f/\alpha}$, there exist threshold values $\bar{\gamma}_1(\Delta_\theta) < \bar{\gamma}_2(\Delta_\theta) < \bar{\gamma}_3(\Delta_\theta)$ such that the following holds:*

1. *With $\gamma < \bar{\gamma}_1(\Delta_\theta)$, there is excessive signalling,*
2. *with $\bar{\gamma}_1(\Delta_\theta) < \gamma < \bar{\gamma}_2(\Delta_\theta)$, there is oversignalling,*
3. *with $\gamma > \bar{\gamma}_2(\Delta_\theta)$, there is undersignalling.*

Proof. Consider the cut-off point between excessive signalling and oversignalling, given by $\Delta_\theta^{\max} - 2\gamma\theta_H/\alpha = \left(2\sqrt{\alpha+\gamma}\sqrt{\Delta_f}\right)/\alpha - 2\gamma\theta_H/\alpha$. Denote this cut-off as $C_{eo}(\gamma)$.With $\gamma = 0$, the expression becomes $2\sqrt{\Delta_f/\alpha}$, so we have excessive signalling for all admissible values of Δ_θ. Note that

$$\frac{\partial^2 C_{eo}}{\partial \gamma^2} = -\frac{1}{2}\frac{\sqrt{\Delta_f}}{\alpha\left(\alpha+\gamma\right)^{\frac{3}{2}}} < 0.$$

This implies that C_{eo} is a strictly concave function. Also note

$$\lim_{\gamma\to\infty}\frac{\partial C_{eo}}{\partial \gamma} = -\infty.$$

Consider some $\Delta_\theta' < C_{eo}(0) = 2\sqrt{\Delta_f/\alpha}$. The two properties derived above imply that there is some γ' such that $C_{eo}(\gamma') = \Delta_\theta'$. Concavity implies that for all $\gamma'' \in (0,\gamma')$, we have

$$C_{eo}(\gamma'') > \frac{\gamma''}{\gamma'}C_{eo}(0) + \left(\frac{\gamma'-\gamma''}{\gamma'}\right)C_{eo}(\gamma') > C_{eo}(\gamma').$$

Next, concavity of C_{eo} and the fact that $C_{eo}(\gamma') < C_{eo}(0)$ together imply that C_{eo} is decreasing in γ'. Concavity then implies that for all $\gamma''' \in (\gamma',\infty)$, we have that $C_{eo}(\gamma''') < C_{eo}(\gamma')$. Hence, γ' is the unique threshold such that the principal faces excessive signaling with $\gamma < \gamma'$, and faces either oversignaling or undersignaling with $\gamma > \gamma'$.

Next, consider the cut-off point between over- and undersignalling, given by $\Delta_\theta^{\max} - \gamma\theta_H/\alpha = \left(2\sqrt{\alpha+\gamma}\sqrt{\Delta_f}\right)/\alpha - \gamma\theta_H/\alpha$. Denote this cut-off as $C_{ou}(\gamma)$. With the exact same arguments as above, we can show that, for given Δ'_θ, there is a unique threshold $\hat{\gamma}$ such that the principal faces oversignaling or excessive signaling with $\gamma < \hat{\gamma}$, and faces undersignaling with $\gamma > \hat{\gamma}$. Since we have $C_{eo}(\gamma) < C_{ou}(\gamma)$ for all $\gamma > 0$, the result is established. ■

Thus for low enough γ, and hence if the conflict of interest is not too strong, we always have excessive signaling, just as we had in our benchmark model. For intermediate values of γ, we have a case of oversignalling. If the conflict of interest is strong enough, we have undersignalling. This also implies that for low enough γ, the principal chooses not to monitor. Yet, once γ is high enough, and the conflict of interest is sufficiently high, the principal does want to monitor.

The intuition for this result is as follows. First, the signalling effect becomes weaker as γ increases. When the conflict of interest increases, it is less difficult for the high ability type to differentiate from the low ability type: when mimicking the high type, the low type now has to incur not only the lower payoff associated with a more risky project, but also the higher effort. Second, an increase in γ implies that the shirking effect is stronger. For the same project, the agent now has to exert more effort, regardless of his type. Both effects lead to the agent choosing safer projects. Hence, excessive signalling becomes less of an issue.

6 Extension: continuous monitoring

So far, we have assumed that the principal faces the binary choice whether to monitor or not to monitor. Yet, there may be circumstances in which she can commit to monitor with some probability. In this section we analyze this scenario.

Suppose that *a priori,* the principal can commit to monitor with some probability m. The principal will choose m to maximize expected payoffs. The agent's payoff now is

$$B_A = \alpha\left(\theta_i - x\right)x - \gamma x^2 + \left(1-m\right)f(\rho) + mf(\mu),\ i \in \{L, H\}. \tag{18}$$

This can be seen as follows. With probability $1-m$, there is no monitoring, and the principal's posterior belief regarding the agent's quality equals the prior belief ρ. With probability m, there is monitoring, and the principal can update her belief. Thus, with $m = 1$ we are in the observability case, and with $m = 0$, we are in the unobservability case. The first-best outcomes of agent and principal are still given by (11) and (12) respectively. Consider the subgame that starts after the principal has chosen m. A sequential equilibrium of that subgame requiresNow consider the case where project choice is unobservable. A sequential equilibrium now requires

$$x_i^* \in \arg\max_x \alpha\left(\theta_i - x\right)x - \gamma x^2 + f\left(\mu(x)\right) + mf(\mu(x)),$$

while (6) is unaffected. This yields the following:

Lemma 1 *The unique separating equilibrium surviving the Intuitive Criterion has* $x_L^* = x_L^{fa}$ *and*

$$x_H^* = \begin{cases} x_H^{fa} & \text{if } m < \frac{1}{4\Delta_f}\frac{\alpha^2\Delta_\theta^2}{\alpha+\gamma} \\ \frac{\theta_L}{2}\frac{\alpha}{\alpha+\gamma} + \frac{1}{\sqrt{\alpha+\gamma}}\sqrt{m\Delta_f} & \text{otherwise.} \end{cases} \quad (19)$$

Proof. Obviously $x_L^* = x_L^{fa}$. Again, the natural candidate for x_H^* in a separating equilibrium is the $\hat{x}$ for which the incentive compatibility constraint for the low type is just binding. The constraint is

$$\alpha\left(\theta_L - x_L^*\right)x_L^* - \gamma\left(x_L^*\right)^2 + mf_L \geq \alpha\left(\theta_L - \hat{x}\right)x - \gamma\left(\hat{x}\right)^2 + mf_H,$$

hence

$$\hat{x} = \frac{\theta_L}{2}\frac{\alpha}{\alpha+\gamma} + \frac{1}{\sqrt{\alpha+\gamma}}\sqrt{m\Delta_f}. \quad (20)$$

For this to be the separating equilibrium we need that $\hat{x} > x_H^{fa}$; otherwise the high type would simply set x_H^{fa}, without the low type having an incentive to mimic that strategy. This implies that to have $x_H^* = \hat{x}$, we require $m \geq \frac{1}{4\Delta_f}\frac{\alpha^2\Delta_\theta^2}{\alpha+\gamma}$. This establishes the result. ■

Insert some explanation here. Now we have:

Theorem 8 *The optimal choice for the principal is to set*

$$m^* = \begin{cases} \frac{(\alpha\Delta_\theta+\gamma\theta_H)^2}{4(\alpha+\gamma)\Delta_f} & \text{if } \Delta_\theta > \Delta_\theta^{\max} - \gamma\theta_H/\alpha, \\ 1 & \text{otherwise.} \end{cases}$$

Proof. The best the principal can do is to achieve his first-best. From (19) and (12), we have that $x_H^* = x_H^{fp}$ if

$$\frac{\theta_L}{2}\frac{\alpha}{\alpha+\gamma} + \frac{1}{\sqrt{\alpha+\gamma}}\sqrt{m\Delta_f} = \frac{\theta_H}{2}$$

or

$$m^* = \frac{(\alpha\Delta_\theta + \gamma\theta_H)^2}{4(\alpha+\gamma)\Delta_f}.$$

For this to be the optimal m, we require, first, that $m^* \in [0,1]$ and, second, that m^* is such that the high type indeed chooses a distortive signal ($x_H^* > x_H^{fa}$). For the first condition, note that $m^* > 0$. It is easy to verify that $m^* = 1$ if $\Delta_\theta = \Delta_\theta^{\max} - \gamma\theta_H/\alpha$. With m^* strictly increasing in Δ_θ, this implies that the first condition is satisfied if $\Delta_\theta < \Delta_\theta^{\max} - \gamma\theta_H/\alpha$. For the second condition, we require, using lemma 1,

$$\frac{(\alpha\Delta_\theta + \gamma\theta_H)^2}{4(\alpha+\gamma)\Delta_f} > \frac{1}{4\Delta_f}\frac{\alpha^2\Delta_\theta^2}{\alpha+\gamma},$$

which immediately simplifies to $(\alpha\Delta_\theta + \gamma\theta_H)^2 > \alpha^2\Delta_\theta^2$, and is satisfied for any $\gamma > 0$. This establishes the result. ■

Intuition. From the pictures. You can move to the left, not to the right. So if you are too far, you just move to your first-best, otherwise you observe with certainty. If there is a cost, things change.

Also nice here: comparative statics. If γ increases, more monitoring. Obvious. If Δ_θ increases, more monitoring. Intuition: starting from optimal m, suppose Δ_θ increases. Then you get less signalling. So you want to increase it again to get back to your first best. That implies more monitoring. All these comparative statics are of course conditional on $m^* < 1$.

7 Conclusion

WILL CHANGE In this paper, we showed that allowing a high type agent to signal his ability by choosing the riskiness of the project to be implemented may or may not be beneficial for the principal. We assume that agents care about their career, and their compensation may be tied to the principal's perception about agents' ability. This ability is assumed to be agents' private information.

More formally, we consider an agent of unknown ability that has to implement a project on behalf of a principal. The agent can choose any project from a continuum of available projects, and has full discretion to do so. Projects differ in the level of risk they involve. More risky projects have a lower probability of success, but yield a higher return if they are succesful. Ceteris paribus, a higher-quality agent has a higher probability of achieving success in any given project. The principal compensates the agent using a profit sharing rule. In addition, the agent also obtain future discounted payoffs (benefits) that depend on the principal's and the market's perception about his ability. Consider the case in which the interests of the principal and the agent are perfectly aligned.[3] The principal would prefer the agent to implement her first-best project choice. If the principal cannot observe the difficulty nature of the project choice, the agent will implement that first-best choice.

However, if the principal can observe the difficulty nature of the project choice, we have a signalling model. In a separating equilibrium a high-quality agent will signal his true type to the principal, by choosing a project that is more risky than his (and her) first-best, in order to convince her of his true type. As usual, such a signal is costly. In our model, it is also costly for the principal. Signalling does not only imply a deviation from the first-best choice of the agent, but also from that of the principal. Hence, the principal is better off if she cannot monitor because the signal that the agent sends will not be informative for the principal.

In the absence of conflict of interest between the principal and the agent, the first

[3] This prevails when the agent does not incur substantial costs in implementing a project.

best choices of project (in terms of their riskiness) of the principal and the agent coincide. Hence, allowing agents to signal their type leads to the agent choosing an excessively risky project. This will make the principal worse off. In such a situation, it is better for the principal to not be able to observe the risk nature of the chosen project.

The above result can be loosely interpreted as that, it is better to base remuneration and (or) promotion on strict output criteria rather than on the discretion of the principal. With strict rules, the principal's impression of her agent does not play a role in the remuneration and promotion decision. Thus, effectively signalling attempt can be prevented.

On the contrary, in the presence of conflict of interest between the principal and the agent, the first best choices of project do no coincide. When it is costly for the agent to exert effort, the agent's first best choice of project will generally be less risky than the principal's first best choice of project. Thus, in this sense the agent 'shirks'. Allowing a high ability agent to signal his type by choosing a riskier project mitigates shirking.

With conflict of interest, signalling is beneficial for the principal if and only if the difference in ability between the high type and low type agents is sufficiently high. Here, the high ability agent does not have to signal too much in order to convince the principal that he is of high ability. However, when the difference in ability is small, the high ability agent will have to send a very strong signal to the principal. It implies that the chosen project might be too risky from the principal's point of view. Hence, signalling will make the principal worse off. The principal can avoid signalling by not letting the agent's impression plays a role in her decision. This can be done, for instance, by deliberately not to acquire information about the risk nature of the chosen project and by using a strict rule, e.g. output rule, rather than using a principal's discretionary rule in the remuneration and promotion policies.

References

[1] Cho, In-Koo and David Kreps (1987), "Signalling Games and Stable Equilibria", *Quarterly Journal of Economics*, 102, pp.179-221.

[2] Friebel, Guido and Michael Raith (2004), "Abuse of Authority and Hierarchical Communication", *RAND Journal of Economics*, 35, pp.224-244.

[3] Hirschleifer, David and Anjan Thakor (1992), "Managerial Conservatism, Project Choice and Debt", *Review of Financial Studies*, 5, pp.437-470.

[4] Holmstrőm, Bengt (1982), "Managerial Incentives-A Dynamic Perspective," in *Essays in Economics and Management in Honors of Lars Wahlbeck*, Helsinki-Finland: Swedish School of Economics.

[5] Holmstrőm, Bengt (1999), "Managerial Incentive Problems - A Dynamic Perspective", *Review of Economic Studies*, 66, pp.169-182.

[6] Holmstrőm, Bengt and Joan Ricart I Costa (1986), "Managerial Incentives and Capital Management," *Quarterly Journal of Economics*, 101, pp.835-860.

[7] Kanodia, Chandra, Robert Bushman, and John Dickhaut (1989), "Escalation Errors and the Sunk Cost Effect: An Explanation Based on Reputation and Information Asymmetries", *Journal of Accounting Research*, 27, pp.59-77.

[8] Zwiebel, Jeffrey (1995), "Corporate Conservatism and Relative Compensation", *Journal of Political Economy*, 103, pp.1-25.