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Promotion and Work Incentive for a Future Job

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We presented a simple model in which agents could determine effort level with the prospect of promotion. Even without any increase of payment or fringe benefits, promotion could provide an incentive for hard work because it could be a signal of one's ability and the possibility of a better job offer in one's future career. Outside firms that cannot observe the agents' current performance use promotion status in order to predict the agents' ability. We point out that some of the results of the standard career concerns model do not hold here. Because promotion is a binary decision, extra effort becomes effective only when the promotion has not been made without it. This shows that the dispersion of an agent's ability and noise as well as well-known signal-to-noise ratio play important roles in promotion.

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I. Introduction

The study of incentive structures is central to the analysis of all economic activities. In many economic organizations, incentives are provided through monetary compensation. A vast literature exists, describing how firms design explicit contracts in order to induce employees to work in the firm's interest. However, in the case of public agencies, financial incentives play a much more limited role. As stated in Dewatripont and Tirole (1999b), a government agency is supposed to pursue social welfare, which is difficult to measure and therefore impossible to reward directly. In other words, if the outputs are not verifiable, they cannot be used as the basis of a contract, which should be ultimately enforceable by a third party. It

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is often observed that people in the public sectors work as hard as those in the private sectors; the question is what drives them.[1]

In his seminal paper, Holmström (1982 / 1999) constructed a career concerns model and explained the incentive of agents in the situation of non-contractible performance. In his model, an agent considers the effect of current performance on future compensation because the future labor market uses the agent's current output to update beliefs about ability. Good performance today can at least partially reveal the agent's talent; and therefore, he/she will be awarded in the future by acquiring a better job. In other words, the agent exerts effort not to maximize the current pay which could be fixed, but to affect the perceptions of others which ultimately will determine his/her expected wage in the future.

The above argument has been extended in various ways and the logic of career concerns was applied to a wide array of fields. It is beyond the scope of this paper to survey the entire literature but some of the theoretical developments are worth mentioning.[2] For example, Gobbons and Murphy (1992) studied how the agent's career concerns affect the optimal contract when explicit output-contingent contracts are available. Extensions such as Milgrom and Roberts (1988) and Milgrom (1988) and Prendergast (1990) analyzed influence activities and institutional responses, meaning that the agent spends his/her resource to influence the authority's belief about his/her ability. Competition between multiple agents and the adaption of a relative performance scheme in the context of career concerns were also studied in numerous papers such as MacLeod and Malcomson (1988), Zabojnik, Zan and Bernhardt (2001), and Koch and Peyrache (2005).

Effects of information structure that the future employer can access have been another important topic. Dewatripont, Jewitt and Tirole (2009a, 2009b) derived general results on comparisons of information structures. Note that information to the future employer becomes more important especially under asymmetry between the current principal and the future employer. It is quite a strong assumption that the future (potential) principals can share the same information as the current employer. For instance, retired public workers usually start their new career in private sectors.[3] It is hard to imagine that private sector employers can have full access to the agent's performance in the public sector. In particular, Mukherjee (2008a, 2008b) and Wolinksky (2012) studied how much information the initial employer will strategically disclose about the worker's quality to influence

[1] According to a National Assembly report, from 2003 to 2008 the death of 414 public workers was determined as having resulted from overtime work in Korea.

[2] The list of early works is from Borland (1992). Recently the laboratory experiment is also conducted to test the effectiveness of career concerns such as Irlenbusch and Sliwka (2006) and Koch et al. (2009).

[3] The average retirement age of public servants in Korea was 49 years old in 2006. Most of them should start a new career in private sectors.

incentives when workers have career concerns.

This paper adds to the literature addressing the effects of different information to the future employer, by considering a specific and realistic situation. We assume that the current principal makes a decision whether to promote the agent or not based on the current performance. The future employer can observe only *the promotion outcome*, but *not today's performance*. The promotion status is useful in predicting the agent's ability, if the current principal also wants a talented agent to take the promoted job. The main goal of this paper is to verify the conjecture that some of the results in the standard model may not hold in this setup.

This is not the first study by any means, in which promotions serve as a signal about ability. For example, Waldman (1984) analyzed a two-period model in which a fully informed incumbent strategically sets an inefficiently high threshold for promotion in order to prevent competitors from offering good wage proposals. Greenwald (1986), Ricart I Costa (1988), Bernhardt (1995), and Waldman (1990) also considered promotion in various setups but focused on the current principal's strategic behavior and optimal contracts. We depart from the above promotion models by focusing on the effects of the distributional characteristic of agents' ability - especially the variance - and comparing the results with those of the Homström's standard career concerns model. Interestingly enough, the opposite results to the standard career concerns model may arise.

The intuition of the main result is as follows. Suppose that an agent showed a high performance. This high output could be the result of his/her high ability or that of pure luck. If the variance of the ability is high, then more probably this good output is the outcome of his/her talent. Then in the standard model, when the future employer updates his belief of the agent's talent after observing the good performance, he will put high weight on the ability. This generates a good incentive for the agent to make larger effort. The result could be different in the promotion model - only promotion status is available to the future employer. The process of measuring the ability, given the performance level in the standard career concerns model, will be replaced by the following two steps, 'promotion decision based on performance by the current principal' and 'the ability prediction by the future employer given the promotion status.'

The first step makes a difference. Because promotion is a binary choice, exerting extra effort is useless if the promotion would have been made without it anyway. In other words, extra effort will have a meaning only when the performance without it is exactly at the promotion threshold level. The more dispersed a distribution of the performance given an effort level is, the less frequently this event that the performance falls at the threshold level happens. Therefore, the high variance of the worker's ability may reduce the work incentive.

Lastly, it is worthwhile to clarify the meaning of promotion before proceeding any further. There is no clear consensus about what promotion means and various implications have been pursued. In economics, the goal of promotion in an organization is much emphasized as providing incentives as well as assigning people to the jobs that best suit their abilities. That is, employees work hard in the hope of winning a promotion to another job, which entails a different set of responsibilities and compensations.[4] To focus on how to mitigate moral hazard and provide incentives through concern for future jobs, we disregard all the privilege associated with the promoted job, including earnings, and assume that there is no issue of job specific skill. Hence, the only role of promotion in this paper is to generate relevant information for the future employers.

The structure of the paper is as follows. In section 2, we describe the key results in the basic setup and provide two extensions. In section 3, an application to multiple agents is presented. The conclusion is stated in section 4.

II. Promotion Model

2.1. Setup

The simplest framework to analyze work incentive for a future job is adapted here. A principal employs an agent for a task denoted by J. The first period output of J is $x_1 = \theta + e + \varepsilon$ where θ is the agent's ability, e is the effort amount, and ε is a random shock. θ is unknown both to the principal and the agent. In particular, θ follows a normal distribution of $N(0, \sigma_\theta^2)$. ε also follows a normal distribution of $N(0, \sigma_\varepsilon^2)$. Throughout the paper, θ and ε are assumed to be independent of each other. The agent incurs a cost of making an effort, and the cost function is denoted by $C(e)$. As usual, it is assumed that $C(0) = 0$, $C'(e) > 0$, $\lim_{e\to 0} C'(e) = 0$ and $\lim_{e\to\infty} C'(e) = \infty$, in order to guarantee a unique interior solution. Though x_1 is not contractible, it is observable and the principal can use it to infer θ and e.

In the second period, the agent may be promoted to another job denoted by J'. If he is promoted, then an outside worker is hired and J is performed by him/her. If no promotion is made, the agent sticks to J, and J' is conducted by an outside worker. To make a fair comparison, we assume that the (average) ability of the outside worker is 0. Let x_2 be the second period output of a worker performing J, x_2' be that of J', and I be the indicator function showing promotion status.[5] We assume that J' is more important to the firm than J. Specifically, the firm's total output is $X = x_1 + x_2 + (1+k)x_2'$ where $0 < k < 1$ measures the additional benefit

[4] To see the various results on these matters, consult Valsecchi (2008) which surveys the theoretical models of job assignment with special attention to promotion and career profiles.

[5] $I = 1$ if the agent is promoted, and $I = 0$ if otherwise.

of J' over J. Because in this model the incentives are provided only by the prospect of promotion, the agent (and the outside worker) will make no effort in the second period and θ will be his/her performance.[6] Then the expected value of X given x_1 becomes $x_1 + (1-I)E[\theta \mid x_1] + I(1+k)E[\theta \mid x_1] = x_1 + E[\theta \mid x_1] + I \times kE[\theta \mid x_1]$.[7] It is straightforward that the firm will promote the agent only when his ability is expected be higher than 0.

The agent will be paid the fixed amount in both periods. Without loss of generality, the amount is assumed to be 0. After the second period, the agent will leave the firm and pursue another career. A better wage offer for the promoted agent will be made by outside firms. Unlike previous literature of career concerns, the outside firms can observe neither the first period output nor that of the second period. Only the promotion status will be public information. The timing of the game is summarized as follows.

The decision on e is made.
θ and ε are realized.
x_1 is obtained.
The promotion decision is made by the principal after observing x_1.
x_2 and x_2' are obtained.
The outside firms make a wage offer to the agent, based on the promotion status.

In the standard career concerns model, the outside firm can observe the first period output and moreover, there is no second period such that promotion is not an issue. For future reference, we are going to call this **the model with direct observation**.

2.2. Critical event and Signal-to-factors Ratio

Let μ be the difference in future wage between the promoted agent and the failed one. Because the outside labor market is perfectly competitive, the offered wage must be equal to the expected ability, given the promotion status. That is, $\mu = E_o(\theta \mid I=1) - E_o(\theta \mid I=0)$. The subscript o means that it is the expectation of the outside firms. Let the probability of promotion and the equilibrium effort level be denoted by $P(e)$ and e^*, respectively. Then the agent's objective function becomes

[6] For simplicity, there is no random shock for the second period output either.

[7] If $I=1$, then $E(x_2)=0$ and $E((1+k)x_2') = (1+k)E[\theta \mid x_1]$. If $I=0$, then $E((1+k)x_2')=0$ and $E(x_2) = E[\theta \mid x_1]$.

$$
\begin{aligned}
&-C(e)+P(e)E_o(\theta \mid I=1)+(1-P(e))E_o(\theta \mid I=0) \\
&=-C(e)+P(e)\mu+E_o(\theta \mid I=0).
\end{aligned}
$$

Along the equilibrium, the principal and the outside firms perfectly expect e^* though they cannot observe the actual effort level. The expected promotion given x_1 and e^* is given as follows.

$$
\begin{Bmatrix}
E[\theta \mid x_1-e^*] \geq 0: \text{the agent is promoted.} \\
E[\theta \mid x_1-e^*] < 0: \text{the agent is not promoted.}
\end{Bmatrix}
$$

$$
\Rightarrow E(\theta)+\frac{Cov[\theta, x_1-e^*]}{Var[x_1-e^*]}(x_1-e^*) \geq 0: \text{the agent is promoted.}
$$

$$
\Rightarrow \frac{\sigma_\theta^2}{\sigma_\theta^2+\sigma_\varepsilon^2}(\theta+\varepsilon+e-e^*) \geq 0: \text{the agent is promoted.}
$$

The outside firm's expectation about the agent's ability along the equilibrium is the following.

$$
\begin{Bmatrix}
E_o[\theta \mid I=1]=E_o\left[\theta \mid \frac{\sigma_\theta^2}{\sigma_\theta^2+\sigma_\varepsilon^2}(\theta+\varepsilon) \geq 0\right]=\sqrt{\frac{\sigma_\theta^2}{\sigma_\theta^2+\sigma_\varepsilon^2}}\frac{\phi(0)}{1-\Phi(0)}, \\
E_o[\theta \mid I=0]=E_o\left[\theta \mid \frac{\sigma_\theta^2}{\sigma_\theta^2+\sigma_\varepsilon^2}(\theta+\varepsilon) < 0\right]=-\sqrt{\frac{\sigma_\theta^2}{\sigma_\theta^2+\sigma_\varepsilon^2}}\frac{\phi(0)}{1-\Phi(0)}
\end{Bmatrix}
$$

$$
\Rightarrow \mu=\sqrt{\frac{\sigma_\theta^2}{\sigma_\theta^2+\sigma_\varepsilon^2}}\frac{2\phi(0)}{1-\Phi(0)}
$$

where ϕ and Φ are the density function and the cumulative density function of the standard normal distribution, respectively.[8] Given e^*, $P(e)$ is driven as follows.

$$
\begin{aligned}
P(e) &= \Pr_{\theta+\varepsilon}[E[\theta \mid x_1-e^*] \geq 0]=\Pr_{\theta+\varepsilon}\left[\frac{\sigma_\theta^2}{\sigma_\theta^2+\sigma_\varepsilon^2}(x_1-e^*) \geq 0\right] \\
&= \Pr_{\theta+\varepsilon}[\theta+\varepsilon \geq e^*-e]=\int_{\frac{1}{\sqrt{\sigma_\theta^2+\sigma_\varepsilon^2}}(e^*-e)}^{\infty} d\Phi(z) \\
&\Rightarrow P'(e^*)=\frac{1}{\sqrt{\sigma_\theta^2+\sigma_\varepsilon^2}}\phi(0).
\end{aligned}
$$

[8] The derivation in detail is given in the appendix.

The agent's objective function, $-C(e)+\mu P(e)+E_o[\theta \mid I=0]$, should be maximized at $e=e^*$. Note that μ and $E_o[\theta \mid I=0]$ are not functions of e, because the outside firms calculate their expectation based on e^*. Hence, we obtain the following first order condition.

$$C'(e^*)=\mu P'(e^*)$$

$$\Rightarrow C'(e^*)=2\frac{\sigma_\theta}{\sigma_\theta^2+\sigma_\varepsilon^2}\frac{\phi(0)^2}{1+\Phi(0)}. \tag{1}$$

Proposition 1 below compares the equilibrium effort level here with that of the direct observation model.

Proposition 1 *The equilibrium effort level in this model is lower (higher) than that of the direct observation model if* $\frac{2\phi(0)^2}{1-\Phi(0)}<(>)\sigma_\theta$.

Proof : If the firm can observe the first period output x_1 and there is no second period, the outside firm will offer $E[\theta \mid x_1-e^*]=\frac{\sigma_\theta^2}{\sigma_\theta^2+\sigma_\varepsilon^2}(x_1-e^*)$. Then the condition for the optimal effort level is the following.

$$\frac{dE\left[\frac{\sigma_\theta^2}{\sigma_\theta^2+\sigma_\varepsilon^2}(\theta+\varepsilon+e-e^*)\right]}{de}\Big|_{e=e^*}=C'(e^*)$$

$$\Rightarrow \frac{\sigma_\theta^2}{\sigma_\theta^2+\sigma_\varepsilon^2}=C'(e^*) \tag{2}$$

The result in the statement is obtained by comparing (1) and (2). ■

$\frac{\sigma_\theta^2}{\sigma_\theta^2+\sigma_\varepsilon^2}$ in the direct observation model has been called the "signal-to-noise ratio".[9] If the first period output x_1 is different from the expected effort level e^*, the outside firms attribute x_1-e^* to the agent's ability as well as pure noise. The more dispersed is the ability distribution relative to that of the noise, the more likely x_1-e^* is to come from the former rather than the latter. The principal will use $\frac{\sigma_\theta^2}{\sigma_\theta^2+\sigma_\varepsilon^2}$ as the weight for the ability to predict the agent's ability, and the equilibrium effort shows a positive relation with it, as in (2).

On the contrary, (1) prescribes the effort level to be determined by both $P'(e^*)$ and μ in this promotion model.

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[9] Technically, the term of "signal-to-noise ratio" is better suited for $\frac{\sigma_\theta^2}{\sigma_\varepsilon^2}$. However, there is one to one relation between $\frac{\sigma_\theta^2}{\sigma_\theta^2+\sigma_\varepsilon^2}$ and $\frac{\sigma_\theta^2}{\sigma_\varepsilon^2}$, and they are interchangeable.

First, $P'(e^*)$ is decreasing in σ_θ^2 and σ_ε^2, meaning that the increase in promotion probability from an additional effort is lower when the agent's ability and noise are more dispersed. Given the equilibrium effort level, the promotion decision depends on the realization of $\theta+\varepsilon$. A marginal increase in the effort level at equilibrium will lead to a larger output at any given $\theta+\varepsilon$. However, it does not always affect the promotion decision, because the promotion is binary - success or failure.

For example, if $\theta+\varepsilon>0$ is realized, then making more effort than the equilibrium level is useless because the promotion would be made without it anyway. More specifically, increasing the effort level from e^* to $e^*+\Delta e$ is effective only when $\theta+\varepsilon=0$ by chance. The event that the performance is at the threshold level, that is, $\theta+\varepsilon=0$, will be called 'the critical event.' The more dispersed the distribution of $\varepsilon+\theta$ is, the rarer is the critical event.

Second, $\mu=\sqrt{\frac{\sigma_\theta^2}{\sigma_\theta^2+\sigma_\varepsilon^2}}\frac{2\phi(0)}{1-\Phi(0)}$ depends on $\frac{\sigma_\theta^2}{\sigma_\theta^2+\sigma_\varepsilon^2}$. The outside firms attribute promotional success both to the ability and pure luck. Note that σ_θ^2 represents the importance of the ability and $\sigma_\theta^2+\sigma_\varepsilon^2$ stands for the total factors - ability and noise. To clarify its meaning, $\frac{\sigma_\theta^2}{\sigma_\theta^2+\sigma_\varepsilon^2}$ will be called "signal-to-factors ratio" in this promotion model, while it will be called "signal-to-noise ratio" in the context of the direct observation model, following the tradition.

In sum, the equilibrium effort level in this model is determined by the probability of the critical event and the signal-to-factors ratio.

Because the informational structure is different, the direction of change in effort level is more interesting than the comparison of the absolute effort level in Proposition 1. For motivational purpose, consider the following scenario: a public enterprise adapted a new recruiting system. Previously all the applicants took a standardized test, and the score determined their employments. Now diverse evaluations are introduced, such as a job interview, review of the statement of purpose and inquiry of recommendation letters. One important change the new system entails is the diversity in workers' ability. Would the increased variance in the distribution of workers' ability makes the agents work harder than before? It is true that many factors should be considered to find the answer. However, an answer can be pursued in Proposition 2 below, assuming that the agents receive a performance-independent reward today and the agents can be promoted based on the performance by the current employer.

Proposition 2

$$\frac{de^*}{d\sigma_\theta}<0\ if\ \sigma_\varepsilon^2<\sigma_\theta^2,$$

$$\frac{de^*}{d\sigma_\theta} > 0 \ if \ \sigma_\varepsilon^2 > \sigma_\theta^2 .$$

Proof : It is clear from (2). ■

In particular, the result of $\frac{de^*}{d\sigma_\theta} < 0$ is interesting because it never arises in the direct observation model. With an increase of the variance of the agent's ability, the signal-to-noise ratio increases, which helps him/her to receive a better wage offer given any x_1. Hence, the incentive to exert extra effort becomes larger in the direct observation model. However, in this promotion model, the increase in the variance of the agent's ability has a negative effect in $P'(e)$. Of course, it also has positive effect in μ. Due to the existence of two counter effects, the outcome depends on the parameter values.

2.3. Strategic Promotion

To focus the work incentive coming from future wage offers, it is assumed that the agent leaves the firm after the second period. We can consider a different situation where the agent will stay with the firm in the third period, performing the task J, and receive a wage equal to his outside option which is determined by the market's perception of his ability.[10] Assuming again that the agent receives 0 (or any fixed amount of wage) for the first two periods, the agent's objective function is the same as before, which is $-C(e)+P(e)\mu+E_o(\theta \mid I=0)$. The firm's objective function given x_1 is given as follows.

$$\begin{aligned} & x_1 + I(1+k)E[\theta \mid x_1] + (1-I)E[\theta \mid x_1] + x_3 - w_3 \\ = & x_1 + I \times kE[\theta \mid x_1] + E[\theta \mid x_1] + E[\theta \mid x_1] - E_o[\theta \mid I] \end{aligned}$$

where x_3 and w_3 are the output and the wage in the third period, respectively. Because $E_o[\theta \mid I]$ as well as $I \times kE[\theta \mid x_1]$ is dependent on I, we cannot conclude that $E[\theta \mid x_1] \geq 0$ is the criterion of the firm's promotion decision. However, it is obvious that there will be a threshold level of $E[\theta \mid x_1]$ above which the promotion will be made. Let m be the equilibrium threshold.

$$E[\theta \mid x_1 - e^*] \geq m \Rightarrow \frac{\sigma_\theta^2}{\sigma_\theta^2 + \sigma_\varepsilon^2}(\theta + \varepsilon + e - e^*) \geq m ,$$

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[10] We thank the editor for suggesting this alternative.

$$P(e) = \Pr_{\theta+\varepsilon}\left[\frac{\sigma_\theta^2}{\sigma_\theta^2+\sigma_\varepsilon^2}(x_1 - e^*) \geq m\right] \Rightarrow P'(e^*) = \frac{1}{\sqrt{\sigma_\theta^2+\sigma_\varepsilon^2}}\phi\left(\frac{\sqrt{\sigma_\theta^2+\sigma_\varepsilon^2}}{\sigma_\theta^2}m\right).$$

In addition, μ is driven as follows.

$$\begin{aligned}\mu &= E_o[\theta \,|\, I=1] - E_o[\theta \,|\, I=1] \\ &= E_o\left[\theta \,|\, \frac{\sigma_\theta^2}{\sigma_\theta^2+\sigma_\varepsilon^2}(\theta+\varepsilon) \geq m\right] - E_o\left[\theta \,|\, \frac{\sigma_\theta^2}{\sigma_\theta^2+\sigma_\varepsilon^2}(\theta+\varepsilon) < m\right] \\ &= \sqrt{\frac{\sigma_\theta^2}{\sigma_\theta^2+\sigma_\varepsilon^2}}\frac{2\phi\left(\frac{\sqrt{\sigma_\theta^2+\sigma_\varepsilon^2}}{\sigma_\theta^2}m\right)}{1-\Phi\left(\frac{\sqrt{\sigma_\theta^2+\sigma_\varepsilon^2}}{\sigma_\theta^2}m\right)}.\end{aligned}$$

When $E[\theta \,|\, x_1] = m$, the firm is indifferent in the promotion decision. $kE[\theta \,|\, x_1]$ is the gain in production from the promotion and μ is the wage increase. Hence, m is obtained from (3) below.

$$\begin{aligned}& kE[\theta \,|\, x_1] = \mu \\ &\Rightarrow km = \sqrt{\frac{\sigma_\theta^2}{\sigma_\theta^2+\sigma_\varepsilon^2}}\frac{2\phi\left(\frac{\sqrt{\sigma_\theta^2+\sigma_\varepsilon^2}}{\sigma_\theta^2}m\right)}{1-\Phi\left(\frac{\sqrt{\sigma_\theta^2+\sigma_\varepsilon^2}}{\sigma_\theta^2}m\right)}.\end{aligned} \tag{3}$$

In sum, the first order condition is driven as follows.

$$C'(e^*) = \frac{2\sigma_\theta}{\sigma_\theta^2+\sigma_\varepsilon^2}\frac{\phi\left(\frac{\sqrt{\sigma_\theta^2+\sigma_\varepsilon^2}}{\sigma_\theta^2}m\right)^2}{1-\Phi\left(\frac{\sqrt{\sigma_\theta^2+\sigma_\varepsilon^2}}{\sigma_\theta^2}m\right)} \tag{4}$$

where m is given by equation (3).

All the effects this study will point out still exist when the comparative analysis are conducted, based on (4) instead of (1). The quantitative results, of course, are different because the promotion decision should be more sophisticated, considering the effect on the wage the firm will pay in the third period.[11] Dealing with this

[11] Specifically, any change in a parameter value leads to different m through (3), which provides another effect on e^*.

subsequent effect involves even more tedious algebra than this study already contains and does not add any additional insights to understanding the work incentive of the agent for career concerns. Rather, we suppress this possibility to bring out results into sharper relief, with the assumption that the agent is supposed to leave the firm for the future job after the second period.

2.4. Working Together

One of the applications of Proposition 2 is "team work." Consider another motivational story: suppose that in a public agency, two workers begin a new team project. The performance of the project is the simple sum of two workers' abilities and efforts and there is no existence of positive or negative externality. Does the team project improve the workers' incentive to make an effort? In other words, does it provide more incentive for the effort than the scheme of working alone and being evaluated individually? To find an answer to this question is the purpose of this subsection.

Suppose that there are two agents, A and B. In a team project, the task must be performed by both agents, that is, $x_1 = \theta_A + e_A + \theta_B + e_B + \varepsilon$. The meanings of θ_A, θ_B, e_A and e_B are self-explanatory. We assume that $(\theta_A, \theta_B)'$ follows a bi-variate normal distribution of $N((0,0)', \Sigma_\theta)$ where $\Sigma_\theta = \begin{pmatrix} \sigma_\theta^2, & 0 \\ 0, & \sigma_\theta^2 \end{pmatrix}$. To make the comparison as simple as possible, we assume that the promotion decision and hiring of the outside firms must be made as a team. This implies that A and B will be promoted (or hired) together or not. However, each agent is supposed to determine the effort level non-cooperatively. The promotion decision is given as follows.

$$\text{The team is promoted if } E[\theta_A + \theta_B \mid x_1 - e_A^* - e_B^*] \geq 0$$

$$\Rightarrow \text{ The team is promoted if } \frac{2\sigma_\theta^2}{2\sigma_\theta^2 + \sigma_\varepsilon^2}(\theta_A + \theta_B + e_A - e_A^* + e_B - e_B^* + \varepsilon) \geq 0 .$$

The promotion probability of A given (e_A, e_B^*) is the following.

$$P_A(e_A, e_B^*) = \Pr[\theta_A + \theta_B + e_A - e_A^* + \varepsilon \geq 0]$$

$$\Rightarrow \frac{\partial P_A(e_A, e_B^*)}{\partial e_A}\Big|_{e_A = e_A^*} = \frac{\phi(0)}{\sqrt{2\sigma_0^2 + \sigma_\varepsilon^2}} .$$

The outside firms' expectation on the team's ability given promotion is given below.

$$E_o(\theta_A + \theta_B \mid I_A = 1) = E_o(\theta_A + \theta_B \mid x_1 - e_A^* - e_B^* \geq 0)$$
$$= \sqrt{\frac{2\sigma_\theta^2}{2\sigma_\theta^2 + \sigma_\varepsilon^2}} \frac{\phi(0)}{1 - \Phi(0)}.$$

Then the equilibrium condition is given as follows.

$$\mu \frac{\partial P_A(e_A, e_B^*)}{\partial e_A}\Big|_{e_A = e_A^*} = C'(e_A^*)$$
$$\Rightarrow \frac{2\sqrt{2\sigma_\theta^2}}{2\sigma_\theta^2 + \sigma_\varepsilon^2} \frac{\phi(0)^2}{1 - \Phi(0)} = C'(e_A^*).$$

Proposition 3 *The agent's effort level is lower (higher) in working as a team than that of the single agent case if* $\frac{1}{\sqrt{2}}\sigma_\varepsilon^2 < (>) \sigma_\theta^2$.

Proof: $\frac{\sqrt{2\sigma_\theta^2}}{2\sigma_\theta^2 + \sigma_\varepsilon^2} < \frac{\sigma_\theta}{\sigma_\theta^2 + \sigma_\varepsilon^2} \Leftrightarrow \frac{1}{\sqrt{2}}\sigma_\varepsilon^2 < \sigma_\theta^2$. ■

The intuition of Proposition 3 is exactly the same as that of Proposition 2. Working and being evaluated as a team allows the signal-to-noise ratio to be more favorable, from $\frac{\sigma_\theta^2}{\sigma_\theta^2 + \sigma_\varepsilon^2}$ to $\frac{2\sigma_\theta^2}{2\sigma_\theta^2 + \sigma_\varepsilon^2}$, which prescribes the effort level to increase in the direct observation model. By the same token, the signal-to-factors effect in the promotion model is positive. However, there is also a negative effect because the additional introduction of other member's ability lowers the probability of the critical event. Under the condition of $\frac{1}{\sqrt{2}}\sigma_\varepsilon^2 < \sigma_\theta^2$, the negative effect dominates the positive one and further, the equilibrium effort level drops in the promotion model.

III. Correlated Performance

When there are multiple agents and their performances are correlated, the future principal can utilize them to obtain a better prediction of ability. Following Lazear and Rosen (1981), economic research has been developed in order to examine the incentive effects of promotion schemes via tournament. Gibbons (1997) and Prendergast (1999) offer excellent surveys, including the tournament theory.

In particular, the role of career concern in the situation of observable and correlated performances has been well studied. For example, Meyer and Vickers (1997) used the career concerns model to analyze the effect of comparative performance on the effort level. In their setup, two agents who care for the future wage work independently. Specifically, there are two agents, A and B, and two missions, X and Y. The first period outputs in X and Y are determined by $x_1 = \theta_A + e_A + \varepsilon^X$ and $y_1 = \theta_B + e_B + \varepsilon^Y$. (θ_A, θ_B) follows a bi-variate normal distribution of $(\theta_A, \theta_B)' \sim N((0,0)', \Sigma_\theta)$ where $\Sigma_\theta = \begin{pmatrix} \sigma_\theta^2, & \sigma_{ab} \\ \sigma_{ab}, & \sigma_\theta^2 \end{pmatrix}$. $(\varepsilon^X, \varepsilon^Y)$ also follows another bi-variate normal distribution of $(\varepsilon^X, \varepsilon^Y)' \sim N((0,0)', \Sigma_\varepsilon)$ where. $\Sigma_\varepsilon = \begin{pmatrix} \sigma_\varepsilon^2, & \sigma_{xy} \\ \sigma_{xy}, & \sigma_\varepsilon^2 \end{pmatrix}$. (θ_A, θ_B) and $(\varepsilon^X, \varepsilon^Y)$ are assumed to be independent. The future principal can observe x_1 and y_1 in the direct observation model. Each agent's current payment is fixed; however the future wage is equal to $E(\theta_A \mid x_1 - e_A^*, y_1 - e_B^*)$ and $E(\theta_B \mid x_1 - e_A^*, y_1 - e_B^*)$, respectively. Meyer and Vickers (1997) showed that the effort level with the comparative performance scheme is higher (lower) than that of a single agent one if

$$\left(\frac{\sigma_\theta^2}{\sigma_\theta^2 + \sigma_\varepsilon^2} \sigma_{ab} + \frac{\sigma_\varepsilon^2}{\sigma_\theta^2 + \sigma_\varepsilon^2} \sigma_{xy} \right) (\sigma_{xy} - \sigma_{ab}) > (<) 0 . \tag{5}$$

A modified signal-to-noise ratio is again the key in understanding (5). For simplicity, consider the case of $\sigma_{ab} = 0$ and $\sigma_{xy} \neq 0$. Then, (5) becomes $(\frac{\sigma_\theta^2}{\sigma_\theta^2+\sigma_\varepsilon^2}\sigma_{ab} + \frac{\sigma_\varepsilon^2}{\sigma_\theta^2+\sigma_\varepsilon^2}\sigma_{xy})(\sigma_{xy} - \sigma_{ab}) = \frac{\sigma_\varepsilon^2}{\sigma_\theta^2+\sigma_\varepsilon^2}\sigma_{xy}^2 > 0$ and the effort level under the comparative performance scheme is higher than that of a single agent. ε^Y in y_1 is correlated with ε^X in x_1 and, thus, the additional information from y_1 decreases the effective variance of the noise in evaluating the ability of A. Therefore, the weight which the principal puts on the noise is lower than that of the independent evaluation. Because the (modified) signal-to-noise ratio becomes favorable, the agent's effort level is larger than that of a single agent. On the contrary, assume $\sigma_{ab} \neq 0$ and $\sigma_{xy} = 0$. Then (5) becomes $(\frac{\sigma_\theta^2}{\sigma_\theta^2+\sigma_\varepsilon^2}\sigma_{ab} + \frac{\sigma_\varepsilon^2}{\sigma_\theta^2+\sigma_\varepsilon^2}\sigma_{xy})$ $(\sigma_{xy} - \sigma_{ab}) = -\frac{\sigma_\theta^2}{\sigma_\theta^2+\sigma_\varepsilon^2}\sigma_{ab}^2 < 0$. Because of the additional information about θ_A from y_1, the effective variance of A's ability decreases and the signal-to-noise ratio becomes less favorable to the agent. Then the equilibrium effort level drops with the comparative performance evaluation.

In the promotion situation, having multiple agents generates the issue of competition, given the hierarchical structure of the organization. To observe how the result changes, we assume that the two agents compete for one promotional job and the future principal only observes the promotional status.[12] Recall that in this

[12] To compare the result with that of the previous literature, we continue to assume that the agents

subsection A and B are two agents and their performances are represented by $x_1 = \theta_A + e_A + \varepsilon^X$ and $y_1 = \theta_B + e_B + \varepsilon^Y$. After observing their outputs, the current principal decides the promotion for two agents. Because there is only one promotional job for the agents, either A or B must be promoted in the second period.

To simplify the notation, two agents' cost functions are assumed to be identical. In addition, we assume $\sigma_{ab} > 0$ and $\sigma_{xy} > 0$ because the result of other cases can be driven by exactly the same way. The condition of A's promotion is given as follows:

$$E(\theta_A \mid x_1 - e_A^*, y_1 - e_B^*) \geq E(\theta_B \mid x_1 - e_A^*, y_1 - e_B^*)$$
$$\Rightarrow \begin{bmatrix} (\sigma_\theta^2, \sigma_{ab}) Var[x_1 - e_A^*, y_1 - e_B^*]^{-1} \begin{pmatrix} x_1 - e_A^*, \\ y_1 - e_B^* \end{pmatrix} \\ \geq (\sigma_{ab}, \sigma_\theta^2) Var[x_1 - e_A^*, y_1 - e_B^*]^{-1} \begin{pmatrix} x_1 - e_A^*, \\ y_1 - e_B^* \end{pmatrix} \end{bmatrix}$$
$$\Rightarrow x_1 - e_A^* \geq y_1 - e_B^* .$$

The probability of A's promotion and its derivative with respect to effort level are obtained below.

$$P_A(e_A, e_B) = \Pr[\theta_A + \varepsilon^X + e_A - e_A^* \geq \theta_B + \varepsilon^Y + e_B - e_B^*]$$
$$\Rightarrow \frac{\partial P_A(e_A, e_B^*)}{\partial e_A}\Big|_{e_A = e_A^*} = \frac{1}{\sqrt{2\sigma_\theta^2 + 2\sigma_\varepsilon^2 - 2\sigma_{xy} - 2\sigma_{ab}}} \phi(0) .$$

In addition, μ_A is obtained as follows.

$$E_o(\theta_A \mid I_A = 1) = E_o(\theta_A \mid \theta_A + \varepsilon^X \geq \theta_B + \varepsilon^Y)$$
$$= \frac{\sigma_\theta^2 - \sigma_{ab}}{\sqrt{\sigma_\theta^2}\sqrt{2\sigma_\theta^2 + 2\sigma_\varepsilon^2 - 2\sigma_{xy} - 2\sigma_{ab}}} \frac{\phi(0)}{1 - \Phi(0)}$$
$$\Rightarrow \mu_A = \frac{2\sigma_\theta - 2\frac{\sigma_{ab}}{\sigma_\theta}}{\sqrt{2\sigma_\theta^2 + 2\sigma_\varepsilon^2 - 2\sigma_{xy} - 2\sigma_{ab}}} \frac{\phi(0)}{1 - \Phi(0)}$$

The equilibrium condition becomes the following.

behave non-cooperatively.

$$\mu_A \frac{\partial P_A(e_A, e_B^*)}{\partial e_A}\Big|_{e_A=e_A^*} = C'(e_A^*)$$

$$\Rightarrow \frac{\sigma_\theta - \frac{\sigma_{ab}}{\sigma_\theta}}{2\sigma_\theta^2 + 2\sigma_\varepsilon^2 - 2\sigma_{xy} - 2\sigma_{ab}} \frac{2\phi(0)^2}{1-\Phi(0)} = C'(e_A^*). \tag{6}$$

Proposition 4 *The agent's effort level in the model of this section is lower (higher) than that of the single agent case if*

$$(\sigma_\theta^2 + \sigma_\varepsilon^2) - \frac{\sigma_{ab}}{\sigma_\theta^2}(\sigma_\theta^2 - \sigma_\varepsilon^2) - 2\sigma_{xy} > 0 (< 0). \tag{7}$$

Proof: (7) is straightforward because

$$\frac{\sigma_\theta - \frac{\sigma_{ab}}{\sigma_\theta}}{2\sigma_\theta^2 + 2\sigma_\varepsilon^2 - 2\sigma_{xy} - 2\sigma_{ab}} - \frac{\sigma_\theta}{\sigma_\theta^2 + \sigma_\varepsilon^2} < 0 (> 0)$$

$$\Leftrightarrow (\sigma_\theta^2 + \sigma_\varepsilon^2) - \frac{\sigma_{ab}}{\sigma_\theta^2}(\sigma_\theta^2 - \sigma_\varepsilon^2) - 2\sigma_{xy} > 0 (< 0). \quad \blacksquare$$

The promotion condition with correlated performances is $\theta_A + \varepsilon^X \geq \theta_B + \varepsilon^Y$ while that of a single agent is $\theta_A + \varepsilon^X \geq 0$. Because $\theta_B + \varepsilon^Y$ is a random variable, the uncertainty of the total factors increases in determining A's promotion as long as the correlation between the two jobs is not strong enough. Specifically, if $\sigma_\theta^2 + \sigma_\varepsilon^2 - 2\sigma_{xy} - 2\sigma_{ab} > 0$ then the comparative scheme will generate a negative effect in inducing the agent's effort because it lowers the probability of the critical event.

There is another effect which comes from the signal-to-factors ratio. To see this clearly, assume first that $\sigma_{ab} > 0$ and $\sigma_{xy} = 0$ as well as $\sigma_\theta^2 + \sigma_\varepsilon^2 - 2\sigma_{ab} > 0$. The successful promotion informs the outsider firms that A's performance is better than B's. Specifically, the signal for A's ability is the correlation between θ_A and $\theta_A - \theta_B$, which is $\sigma_\theta^2 - \sigma_{ab}$. Hence, the signal-to-factors ratio is lower than σ_θ^2 if $\sigma_{ab} > 0$. Because both effects - the low probability of the critical event and a drop of the signal-to-factor ratio - work in a negative way, the equilibrium effort level under the comparative scheme is lower than that of the single agent case if $\sigma_{ab} > 0$ and $\sigma_\theta^2 + \sigma_\varepsilon^2 - 2\sigma_{ab} > 0$.

To see the difference between the promotion model and the direct observation one, consider now the case of $\sigma_{ab} = 0$ and $\sigma_{xy} > 0$. As it was explained before, the effort level of the comparative scheme is larger than that of the single agent case, if the direct observation is assumed. On the contrary, in this promotional situation,

$\sigma_{ab} = 0$ implies that the additional effect in terms of the signal for A's ability does not exist because the correlation between θ_A and $\theta_A - \theta_B$ is just σ_θ^2. Therefore, the difference in effort levels only depends on the change of the probability of the critical event, that is, the sign of $\sigma_\theta^2 + \sigma_\varepsilon^2 - 2\sigma_{xy} - 2\sigma_{ab} = \sigma_\theta^2 + \sigma_\varepsilon^2 - 2\sigma_{xy}$. Assuming $\sigma_\theta^2 + \sigma_\varepsilon^2 - 2\sigma_{xy} > 0$, the reduced chance of the critical event makes the equilibrium effect level with comparative performance lower than that of the single agent, while it rises with the comparative performance in the direct observation model.

IV. Conclusion

The design of incentives, information availability and contractibility are closed related. When the principal cannot form a contract based on the current output due to its non-contractibility, other ways of providing an incentive must be developed. The career concerns model captures a motivation of work, in which good performance today can be a signal of high productivity. The employee can be rewarded later through a better job offer by future potential employers. This approach assumes that the future employer can observe today's performance and, therefore he/she creates an expectation about the worker's ability based on it.

This paper begins with a simple argument that the future employer usually has limited access to the current outcome in reality. For instance, the objectives of the public service are very abstract and the evaluation for public servants primarily comprises the subjective satisfaction of the superior. Moreover, the government itself, is sometimes reluctant to reveal all the relevant information about the agencies' performance due to political concerns. However, it is easy to acquire information on what kind of position one has taken or which rank one had in a public organization.

What should be the effect of different job designs on the agent's effort level when promotion is determined by the current employer but the future job offer is made only based on the promotion status by the outsider? In the standard career concerns model, the key parameter is the signal-to-noise ratio which is basically the variance of ability over the variance of noise. If this ratio is high, then future employers attribute good performance to the ability effect and therefore, an incentive to raise the current outcome through higher effort becomes larger. We find that the probability of the critical event is another key parameter value here.

The benefit to the agent from the extra effort can be realized through two steps. The first one is "promotion" and the other one is "the expected ability given the promotion." The latter is determined by a signal-to-factors ratio as in the standard career concerns model. However, the first one depends on the sum of the variances of two variables, ability and noise. Because promotion is a binary choice (success/failure), exerting an extra effort becomes beneficial only when the promotion would not have been made without it. Hence, dispersion of the two variables will have a negative effect because it makes the event rare that the promotion would just be made without the extra effort.

We provide several situations in which this additional effect leads us to the opposite result from the classical career concerns model - a rise in diversity of ability, team work and comparative performance evaluation. The implication in these cases again emphasizes the importance of the effect of information structure on the moral hazard outcome.

Appendix

Derivation of $E(\theta \mid \delta \geq \rho)$**:**

Let $\delta = k_1\theta + \gamma$ where $(\theta, \gamma)' \sim N((0,0)', \Sigma)$ where $\Sigma = \begin{pmatrix} \sigma_\theta^2, & \sigma_{\theta\gamma} \\ \sigma_{\theta\gamma}, & \sigma_\gamma^2 \end{pmatrix}$ and $0 < k_1$. Let $\Delta \equiv \frac{\partial}{\sqrt{k_1^2\sigma_\theta^2 + \sigma_\gamma^2 + 2k_1\sigma_{\theta\gamma}}} = \frac{k_1\theta + \gamma}{\sqrt{k_1^2\sigma_\theta^2 + \sigma_\gamma^2 + 2k_1\sigma_{\theta\gamma}}}$. Then $\Delta \sim N(0,1)$. Let's decompose θ into Δ and the error term, z, which is orthogonal to Δ. This may be interpreted as regressing Δ into θ, that is, $\theta = \lambda\Delta + \sqrt{1-\lambda^2}\,z$ where Δ and z are independent and λ is the correlation coefficient between θ and Δ. Then,

$$
\begin{aligned}
& E(\theta \mid \delta \geq \rho) \\
&= E\left(\theta \mid \Delta \geq \frac{\rho}{\sqrt{k_1^2\sigma_\theta^2 + \sigma_\gamma^2 + 2k_1\sigma_{\theta\gamma}}}\right) \\
&= E\left(\lambda\Delta + \sqrt{1-\lambda^2}\,z \mid \Delta \geq \frac{\rho}{\sqrt{k_1^2\sigma_\theta^2 + \sigma_\gamma^2 + 2k_1\sigma_{\theta\gamma}}}\right) \\
&= \lambda E\left(\Delta \mid \Delta \geq \frac{\rho}{\sqrt{k_1^2\sigma_\theta^2 + \sigma_\gamma^2 + 2k_1\sigma_{\theta\gamma}}}\right) \\
&= \lambda \frac{\phi\left(\frac{\rho}{\sqrt{k_1^2\sigma_\theta^2 + \sigma_\gamma^2 + 2k_1\sigma_{\theta\gamma}}}\right)}{1 - \Phi\left(\frac{\rho}{\sqrt{k_1^2\sigma_\theta^2 + \sigma_\gamma^2 + 2k_1\sigma_{\theta\gamma}}}\right)} \\
&= \frac{Cov(\theta, \Delta)}{\sqrt{Var(\theta)}\sqrt{Var(\Delta)}} \frac{\phi\left(\frac{\rho}{\sqrt{k_1^2\sigma_\theta^2 + \sigma_\gamma^2 + 2k_1\sigma_{\theta\gamma}}}\right)}{1 - \Phi\left(\frac{\rho}{\sqrt{k_1^2\sigma_\theta^2 + \sigma_\gamma^2 + 2k_1\sigma_{\theta\gamma}}}\right)} \\
&= \frac{k_1\sigma_\theta + \frac{\sigma_{\theta\gamma}}{\sigma_\theta}}{\sqrt{k_1^2\sigma_\theta^2 + \sigma_\gamma^2 + 2k_1\sigma_{\theta\gamma}}} \frac{\phi\left(\frac{\rho}{\sqrt{k_1^2\sigma_\theta^2 + \sigma_\gamma^2 + 2k_1\sigma_{\theta\gamma}}}\right)}{1 - \Phi\left(\frac{\rho}{\sqrt{k_1^2\sigma_\theta^2 + \sigma_\gamma^2 + 2k_1\sigma_{\theta\gamma}}}\right)}
\end{aligned}
$$

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