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ABSTRACT

Try Me! On Job Assignments as a Screening Device*

We study the optimal allocation of screening tasks between two agents (incumbent vs. outsider or senior vs. junior) competing for one job. First, we characterize the inefficiencies from the principal's viewpoint of delegating the selection of the screening procedure to the incumbent. In general, the information disclosed by the screening tasks and the turnover rates will be inefficiently small due to the incumbent's willingness to undertake too many of these tasks. Second, we show that it may be optimal for organizations to favour the selection of outsider/junior agents relative to incumbent/senior ones because the former have greater implicit (career concern type) incentives than the latter to exert effort and perform efficiently.

JEL Classification: D21, D73, D80 and L22
Keywords: career concerns, job allocation, personnel economics, relative evaluation and screening

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NON-TECHNICAL SUMMARY

In many economic activities, performance is a direct function of the matching or fit between the objectives of the organization and the competence of its members. It is therefore not surprising to observe that many resources are devoted to screen agents through an implicit or explicit system of relative performance evaluation. Situations in which such a screening procedure naturally emerges may be of a very different nature. Individuals within firms compete intensely for a promotion. Politicians try to be selected by the members of their own party as the leader representative in the upcoming election. Managers propose different lines of products even though only one of them is going to be marketed, etc. All these cases are characterized by a period of intense screening – in which each possibility is accurately tested against the others – followed by the choice of one alternative.

The mechanisms behind these evaluation and selection processes may look trivial. For instance, suppose that the principal is forced to delegate the design of the screening procedure to one of his agents. One might think that such delegation is relatively less costly when the agent in charge of the screening is – on average – better than his competitors. Given his *a priori* dominance he might want to design a process as efficient as possible (i.e. one that reveals the maximum amount of information to the principal) in order to make sure that his superiority becomes apparent. In fact, the Paper shows that the opposite is true: relying on the employees' choice of the screening process is more costly the higher the expected quality of the individual to whom this decision is delegated.

In order to prove this result, we consider the following situation. Two agents whose abilities are uncertain compete for one position in a firm. Agents differ not only in their expected ability (or capacity to perform the tasks or matching with the interests of the firm) but also in the variance of this estimation. The ability of the agent already working in the firm – the 'incumbent' – is less uncertain than that of the agent not previously hired – the 'outsider'. We further assume that there is a fixed number of screening tasks that serve to imperfectly evaluate the true capacity of the two candidates. Given that the principal wants to appoint the agent with highest ability among the two, he will therefore use these tasks to elicit as much information as possible from the two candidates. We show that information revelation is maximized whenever tasks are divided between the two agents, so that some information is obtained about each candidate. Moreover, given that the ability of the incumbent is initially better known than that of his rival, it is optimal for the principal that this agent performs fewer tasks than the outsider. We then analyse the efficiency loss when the allocation of screening tasks has to be delegated to the incumbent. Contrary to the principal's optimal rule, his strategy will depend on the relative expected abilities of the two agents. An incumbent with a lower expected ability than the outsider wants to maximize the probability of leapfrogging the rival. Given his prior disadvantage, this is achieved by maximizing the amount of information revealed during the screening process. It is true that information is more likely to confirm his inferiority than to reveal his superiority. However, it is also his best chance to be *ex-post* considered better than his opponent. In other words, information cannot hurt the agent with lowest ability because, without any pieces of news, he will remain the least valuable agent for the firm and therefore he will definitely not be appointed to the job. A low-ability incumbent then shares the objectives of the principal and therefore he optimally splits tasks between the outsider and himself. Using a symmetric reasoning, it is easy to see that an incumbent who is on average better than the outsider wants to minimize the chances of being leapfrogged by his opponent, which is achieved by minimizing the revelation of information. The best way to minimize the flow of news is to concentrate all the available tasks into the hands of one single agent, so that some information is obtained about that agent but nothing is learned about the other. Moreover, given that the incumbent's ability is by definition better known than the outsider's, the former prefers to undertake all the tasks rather than delegate them to his opponent. Note that the same logic applies if we rather consider the competition for a promotion between a senior agent (whose ability is well known) and a junior one (whose ability is more uncertain). If the allocation of the tasks that will determine which of the two agents is most suitable for the new and more attractive job are delegated to the senior member of the organization, his choice will be all the more inefficient as his expected ability is high.

In the second part of the Paper, we look at another issue related to the optimal design of the screening process. More specifically, we analyse how differences in the career concerns of agents affect their incentives to perform efficiently in the screening activities. To this end, we assume that there are two qualitatively different screening tasks and that each agent has to perform one and only one of them. The principal has to decide which one is performed by each agent. As before, both types of tasks allow the principal to partly infer the ability of the agent. Furthermore, screening tasks are productive (in the sense that they directly affect the utility of the principal) and one of them is more productive than the other. Last, performance in each task depends stochastically not only on the ability of the agent who undertakes it, but also on his effort. Ability is, by assumption, most valuable in the most productive task. Then, without effort considerations, the principal's optimal rule is trivial: he first allocates the agent with highest expected ability to the most productive screening task and then keeps for the job the one with the highest *ex-post* ability given the observed performances. Including the possibility of effort modifies this conclusion. Once agents are allocated to tasks, they do not internalize the possible effects of their effort in the outcome of the screening activity. Hence, they will never exert effort to affect the performance in the screening job. Instead, their incentives to work hard are exclusively due to the fact that a high performance signals a high ability and therefore increases the chances of being selected for the job. We show that the agent whose ability is most uncertain (outsider/junior) has the strongest interest in putting effort in order to bias the perception of his ability. Given that the principal values effort, the outsider/junior then has a comparative advantage over the incumbent/senior due to his higher (career concern type) incentives to exert effort. In particular, he might be selected for the most valuable task even if his expected ability is lower than that of his rival.

To sum up, taking a close look at screening procedures can be important in order to achieve a better understanding of some fundamental issues in organizations. The model draws other general implications for issues related to the efficiency of high turnover rates in organizations, the optimal hiring policy, and the suitability of giving chances to young employees with relatively unknown ability.

1 Introduction

In many economic activities, performance is a direct function of the matching or fit between the objectives of the organization and the competence of its members. It is therefore not surprising to observe that many resources are devoted to *screen* agents through an implicit or explicit system of relative performance evaluation. Situations in which such screening procedure naturally emerges may be of very different nature. Individuals within firms compete intensely for a promotion. Politicians try to be selected by the members of their own party as the leader representative in the upcoming election. Managers propose different lines of products even though only one of them is going to be marketed, etc. All these cases are characterized by a period of intense screening –in which each possibility is accurately tested against the others– followed by the choice of one alternative.

The mechanisms behind these evaluation and selection processes may look trivial. For instance, suppose that the principal is forced to delegate the design of the screening procedure to one of his agents (due maybe to work overload). One might think that such delegation is relatively less costly when the agent in charge of the screening is –on average– better than his competitors. Given his a priori dominance he might want to design a process as efficient as possible (i.e one that reveals the maximum amount of information to the principal) in order to make sure that his superiority becomes apparent. In fact, the paper shows that the opposite is true: relying on the employees' choice of the screening process is more costly the higher the expected quality of the individual to whom this decision is delegated.

In order to prove this result, we consider the following situation. Two agents whose abilities are uncertain compete for one position in a firm. Agents differ not only in their expected ability (or capacity to perform the tasks, or matching with the interests of the firm) but also in the variance of this estimation: the ability of the agent already working in the firm –the "incumbent"– is less uncertain than that of the agent not previously hired –the "outsider". We further assume that there is a fixed number of screening tasks that serve to imperfectly evaluate the true capacity of the two candidates. Each task can be performed by one and only one agent. Given that the principal wants to appoint the agent with highest ability among the two, he will therefore use these tasks to elicit as much information as possible from the two candidates. We show that information revelation is maximized whenever tasks are divided between the two agents, so that some information is obtained about each candidate. Moreover, given that the ability of the incumbent is initially better known than that of his rival, it is optimal for the principal that this agent performs fewer tasks than the outsider. We then analyze the efficiency loss when the allocation of screening tasks has to be delegated to the incumbent. Contrary to the principal's optimal rule, his strategy will depend on the relative expected abilities of the two agents. An incumbent with a lower expected ability than the outsider wants to maximize the probability of leapfrogging the rival. Given his prior disadvantage, this is achieved by maximizing the amount of information revealed during the screening process. It is true that information is more likely to confirm his inferiority than to reveal a superiority. However, it is also his best chance to be ex-post considered better than his opponent. In other words, information cannot hurt the agent with lowest ability because, absent any pieces of news, he will remain the least valuable agent for the firm and therefore he will for sure not be appointed to the job. A low-ability incumbent then shares the objectives of the principal (i.e. he wants to disclose the maximum amount of information) and therefore he optimally splits tasks between the outsider and himself. Using a symmetric reasoning, it is easy to see that an incumbent who is on average better than the outsider wants to minimize the chances of being leapfrogged by his opponent, which is achieved by minimizing the revelation of information.[1] The best way to minimize the flow of news is to concentrate all the available tasks on the hands of one single agent, so that some information is obtained about that agent but nothing is learned about the other. Moreover, given that the incumbent's ability is by definition better known than the outsider's, the former prefers to undertake all the tasks rather than delegate them to his opponent. Overall, there is a conflict of interests between the principal who wants to select the most able agent and the incumbent who wants to maximize his probability of being selected. This clash leads to an inefficiently small amount of information disclosed whenever the selection of the screening procedure is delegated to a relatively good incumbent. Another way of interpreting the results is to say that a high-ability agent works a lot but designs an inefficient screening process while a low-ability agent works less but more efficiently from the principal's perspective. Last, note that the same logic applies if we rather consider the competition for a promotion between a senior agent (whose ability is well-known) and a junior one (whose ability is more uncertain): if the allocation of the tasks that will determine which of the two agents is most suitable for the new and more attractive job are delegated to the senior member

[1] If it was possible, the incumbent would even like to garble the outcome of the screening tests: if no information ever flows in, he is sure of getting the job.

of the organization, his choice will be all the more inefficient as his expected ability is high.

In the second part of the paper, we look at another issue related to the optimal design of the screening process. More specifically, we analyze how differences in the career concerns of agents affect their incentives to perform efficiently in the screening activities. To this purpose, we assume that there are two qualitatively different screening tasks and that each agent has to perform one and only one of them. The principal has to decide which one is performed by each agent. As before, both types of tasks allow the principal to partly infer the ability of the agent. Furthermore, screening tasks are productive (in the sense that they affect directly the utility of the principal) and one of them is more productive than the other. Last, performance in each task depends stochastically not only on the ability of the agent who undertakes it, but also on his effort. Ability is, by assumption, most valuable in the most productive task. Then, absent effort considerations, the principal's optimal rule is trivial: he first allocates the agent with highest expected ability to the most productive screening task and then keeps for the job the one with highest ex-post ability given the observed performances. Including the possibility of effort modifies this conclusion. Once agents are allocated to tasks, they do not internalize the possible effects of their effort in the outcome of the screening activity. Hence, they will never exert effort to affect the performance in the screening job. Instead, their incentives to work hard are exclusively due to the fact that a high performance signals a high ability and therefore increases the chances of being selected for the job. We show that the agent whose ability is most uncertain (outsider/junior) has the strongest interest in putting effort in order to bias the perception of his ability. Given that the principal values effort, the outsider/junior has then a comparative advantage over the incumbent/senior due to his higher (career concern type) incentives to exert effort. In particular, he might be selected for the most valuable task even if his expected ability is lower than that of his rival.

To sum up, taking a close look to screening procedures can be important in order to achieve a better understanding of some fundamental issues in organizations. As developed below, the model draws other general implications for issues related to the efficiency of high turnover rates in organizations, the optimal hiring policy, and the suitability of giving chances to young employees with relatively unknown ability.

Before presenting the model, we would like to briefly mention some papers directly related to ours. Prescott and Visscher (1980) were among the first authors to analyze screening as a determinant of firm's performance, although they focused on very different issues. The model presented in Section 2 differs from theirs mainly in three respects. First, in our paper agents are in competition: our key variable is therefore relative ability and not absolute ability. Second, we fix the number of screening tasks and determine how to efficiently allocate them between different agents rather than optimize over the number of test periods for each agent. Last, our objective is to compare the optimal allocation of tasks from the incumbent's and the principal's perspective in order to determine the costs of delegating the screening process. The extension of our model that includes effort considerations (Section 3) displays some differences with the standard literature on career concerns started with Holmström (1999). In particular, the issue of how exogenous differences in the degree of uncertainty about the agents' ability (due to their "age" within the organization) affect the agents' value for the organization via their different career concern type incentives to perform efficiently was never analyzed before. Last, Meyer (1991) is a classical paper on dynamic incentives and the optimal design of tournaments when the principal can extract a positive but limited amount of information from the performance of his subordinates.

2 Number of job assignments as a screening device

We consider the decision problem of a risk-neutral principal whose mission is to evaluate different types of agents in order to keep the most able one. More precisely, the principal has to choose between two agents ($a \in \{i, o\}$): an incumbent (i) who has been already working in the firm and an outsider (o) who is new to the firm. As we will see below, the model can also be interpreted as the choice between a senior agent (i) who has been in the firm for a long time and a relatively new, junior one (o). The two types of agents differ exclusively in their *ability*, θ_i and θ_o, to perform any task. All the actors have *imperfect but symmetric* information about the (unidimensional) ability parameters of both agents. Formally, we assume that both the principal and the agents know that abilities are drawn from the following distribution:

$$\theta_a \sim \mathcal{N}(m_a, \sigma_a^2) \qquad a \in \{i, o\} \tag{1}$$

Agents differ in two respects. First, different agents have different expected abilities m_a. For our analysis we will consider all the possible pairs (m_i, m_o). Second, the precision of the estimates of the agents' abilities σ_a^2 are also different. For the rest of the paper, we will assume that the ability of the incumbent/senior agent (i) is known with more accuracy than the ability of the outsider/junior one (o), that is:

Assumption $\sigma_i^2 < \sigma_o^2$.

The assumption is necessary for the interpretation of the results but not for the formal analysis (see below). We introduce it because, in our view, the longer the previous labor relation between the principal and the agent, the more accurate is the information that the principal has about the capacity of the agent to perform the tasks required in the firm. In other words, the principal has a better knowledge about how good the "matching" or "fit" between firm and incumbent (or firm and senior employee) is than between firm and outsider (or firm and junior employee). Note that, given the principal's risk-neutrality, this does not give any a priori advantage to the incumbent and senior agents.

The agent selected by the principal to work in the firm receives an exogenously fixed wage b (> 0).[2] The other agent receives zero, which is the outside wage or opportunity cost (not modeled in this paper). We assume for simplicity that the performance of the agent selected for the job is equal to his ability. The principal will therefore retain the individual with highest expected ability conditional on the information available at the selection stage.[3]

In order to increase the knowledge about the ability of the potential employees (and therefore to be able to make better decisions), the principal can assign some screening tasks to the agents. In this section we will consider the following three specific characteristics of the screening process:

(i) A fixed number n of screening tasks have to be allocated between the two competitors (incumbent and outsider or senior and junior). Each task can be performed by one and only one agent. We will compare the first-best outcome (i.e. when the principal decides the optimal allocation of screening tasks) to the case in which the principal is forced to delegate the allocation rule to the incumbent.[4]

(ii) In order to better concentrate on the role of screening tasks as transmitter of information, we assume that they are unproductive, i.e. the performances of the agents in these activities have no intrinsic value for the principal (naturally, the results would not be affected if we removed this assumption).

[2]This is made for simplicity. As we discuss later on, including more sophisticated incentive contracts would not alter the main insights of the paper.

[3]Naturally, our results would also hold if we just assumed positive correlation between ability and performance. All that matters is that high ability must increase the agent's likelihood of being selected.

[4]The total number of screening tasks should also be a choice variable. However, optimizing over two variables would make the model substantially more complex without adding new insights to the trade-offs studied in the paper.

(iii) Performance on a screening task (stochastically) depends exclusively on the ability of the agent to whom it is assigned. Formally, if agent a undertakes task $k \in \{1, ..., n\}$, his performance x_a^k will be:

$$x_a^k = \theta_a + \varepsilon_a^k \qquad \text{where} \quad \varepsilon_a^k \text{ i.i.d. } \mathcal{N}(0, \sigma_\varepsilon^2) \tag{2}$$

The outcome x_a^k is publicly observed. This information is valuable even if the principal does not derive any direct utility from the outcome of the task and the agents are not rewarded for their performance. In fact, each piece of news will give some information about the agent's ability. Therefore, it will influence the decision of the principal to keep one agent or the other, and hence also the payoff of the three actors in this economy.

In the case of the Normal distribution, it is particularly simple to compute the posterior belief about the agent's ability given his performance in the screening tasks. For instance, if agent a realizes tasks 1 to s with performances $\{x_a^1, x_a^2, ..., x_a^s\}$ the posterior distribution of his ability becomes:[5]

$$\theta_a \mid \{x_a^k\}_{k=1}^s \sim \mathcal{N}\left(\lambda_a^s \, m_a + \frac{1-\lambda_a^s}{s} \sum_{k=1}^{s} x_a^k \, , \, \sigma_a^2 \, \lambda_a^s\right) \quad \text{where} \quad \lambda_a^s = \frac{\sigma_\varepsilon^2}{\sigma_\varepsilon^2 + s \, \sigma_a^2} \tag{3}$$

In words, the posterior distribution is also Normal. Its mean is a weighted average of the prior mean and the sum of the observed performances. Its variance is deterministic and decreasing in the number of realized tasks s. Note that, in order to update the beliefs about the agent's ability, the sum of the performances is a sufficient statistic. From now on we will denote total performance in screening tasks as $X_a^s \equiv \sum_{k=1}^{s} x_a^k$. From (2) and the independence of the noise terms, it is straightforward to see that:

$$X_a^s \sim \mathcal{N}\left(s \, m_a, \, s \, (\sigma_\varepsilon^2 + s \, \sigma_a^2)\right) \tag{4}$$

Suppose that the incumbent realizes the first s screening tasks with total performance X_i^s, and the outsider the $n-s$ other ones with total performance X_o^{n-s}. Denote by $w \in \{i, o\}$ the "winner", that is the agent selected by the principal after observing the results of the n screening tasks. Recall that the on-the-job productivity of the winner is equal to his (imperfectly known) ability. The risk-neutral principal will therefore select for the job the agent with highest expected ability conditional on the outcomes

[5] In order to avoid integer problems, we will (without loss of generality) treat s and n as real numbers in the optimization problem below.

of the screening tasks. Formally:

$$w = \arg\max_{\{i,o\}} \left\{ E[\theta_i \,|\, X_i^s], E[\theta_o \,|\, X_o^{n-s}] \right\} \tag{5}$$

Our objective in this section is to determine the costs of delegation. We thus compare the first-best scenario –in which the principal is responsible for the allocation of screening tasks between the two agents– to the second-best one –in which the incumbent/senior decides how to split the screening tasks. Naturally, in both cases the winner is selected by the principal. Given the preferences and payoffs described above, the principal and the agents have conflicting goals: the former wants to maximize the probability of selecting the most able agent while the latter want to maximize their probability of being selected. Because of this tension, the different individuals have different preferences over the revelation of information, and therefore different desires concerning the identity of the agent who should perform the screening activities. In other words, the welfare of the different actors in this economy will crucially depend on the allocation of decision rights of the screening procedure. The timing of our game is summarized as follows.

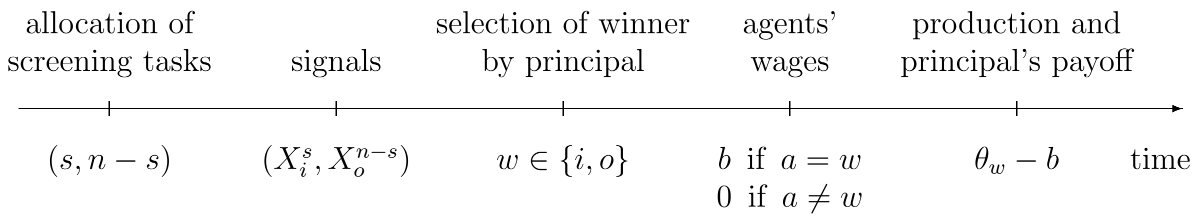

Figure 1. Timing in the "number of job assignments" game.

Note that, in the definition of w given by (5), it is implicitly assumed that the principal keeps one and only one agent. Nothing would change if we included the possibility of not retaining any agent (in which case the principal would spare the wage b). Obviously, keeping one agent is also formally equivalent to retaining both agents and promoting one and only one of them.

2.1 Principal's optimal allocation of screening tasks

Suppose, that the incumbent and the outsider perform s and $(n-s)$ screening tasks, respectively. The ex-ante welfare of the principal is the expected ability of the winner.

This is the sum of two factors. First, V_i^s the expected ability of the incumbent conditional on being selected (i.e. on being the one with highest expected posterior ability after observing the outcomes of the screening tasks) weighted by his probability of being selected. Second, V_o^{n-s} the expected ability of the outsider conditional on being selected, weighted by his probability of being selected. Formally, this can be written as:

$$\begin{aligned} V_i^s &= E\left[\theta_i \,\Big|\, E[\theta_i \,|\, X_i^s] > E[\theta_o \,|\, X_o^{n-s}]\right] \times \Pr\Big[E[\theta_i \,|\, X_i^s] > E[\theta_o \,|\, X_o^{n-s}]\Big] \\ V_o^{n-s} &= E\left[\theta_o \,\Big|\, E[\theta_i \,|\, X_i^s] < E[\theta_o \,|\, X_o^{n-s}]\right] \times \Pr\Big[E[\theta_i \,|\, X_i^s] < E[\theta_o \,|\, X_o^{n-s}]\Big] \end{aligned}$$

Denote by s_p^* the number of tasks optimally delegated to the incumbent from the principal's viewpoint ($n - s_p^*$ are then optimally delegated to the outsider). We have:

$$s_p^* = \arg\max_s \quad V_i^s + V_o^{n-s} \tag{6}$$

We can characterize the optimal choice of the principal.

Proposition 1 *When the principal decides how to allocate the screening tasks, then* $s_p^* \equiv \tilde{s} \in [0, n/2)$ *for all* m_i *and* m_o*. Moreover,* $\partial \tilde{s}/\partial \sigma_i^2 \geq 0$ *and* $\lim_{\sigma_i^2 \to \sigma_o^2} \tilde{s}(\sigma_i^2) = n/2$.

Proof. Using integration by parts and straightforward (although tedious) algebra we get that:[6]

$$V_i^s + V_o^{n-s} = m_i \,\Phi\left(\frac{m_i - m_o}{f(s)}\right) + m_o\left[1 - \Phi\left(\frac{m_i - m_o}{f(s)}\right)\right] + f(s)\,\varphi\left(\frac{m_i - m_o}{f(s)}\right) \tag{7}$$

where $f(s) = \sqrt{\frac{s\,\sigma_i^4}{\sigma_\varepsilon^2 + s\,\sigma_i^2} + \frac{(n-s)\sigma_o^4}{\sigma_\varepsilon^2 + (n-s)\sigma_o^2}}$ and $\varphi(\cdot)$ and $\Phi(\cdot)$ are respectively the density and c.d.f. of the standard Normal distribution. From (7) and given that a property of the Normal distribution is $\varphi'(x) = -x\,\varphi(x)$, we can easily check that:

$$\frac{\partial\, V_i^s + V_o^{n-s}}{\partial\, f(s)} = \varphi\left(\frac{m_i - m_o}{f(s)}\right) > 0,$$

and therefore $s_p^* = \arg\max_s f(s)$.

Simple computations show that $f''(s) < 0$. Given $\sigma_i^2 < \sigma_o^2$, then $f'(n/2) < 0$, so that $\tilde{s} < n/2$.[7] Differentiating $f'(\tilde{s}; \sigma_i^2)$ we obtain that $\partial \tilde{s}/\partial \sigma_i^2 \propto \partial f'(\tilde{s}; \sigma_i^2)/\partial \sigma_i^2 > 0$. Finally, $f'(n/2) = 0$ when $\sigma_i^2 = \sigma_o^2$. □

[6] See any advance book in Statistics dealing with the Normal distribution, or Carrillo and Mariotti (1997, Lemma 1) for a similar proof in a different context.

[7] Note that if $f'(0) > 0$ (for which $n\,\sigma_i^2 > \sigma_\varepsilon^2$ is a sufficient condition) then the solution for $\tilde{s}$ is interior. That is, it is optimal for the principal that both agents realize *some* screening tasks.

The principal is interested in the ability of the "winner". Therefore, he wants to use the screening process to extract as much information as possible from *both* agents. Given that the informational content of each task decreases with the number of tasks previously realized, then maximal information is disclosed when screening tasks are divided between the two agents, independently of their prior expected abilities. If the ex-ante difference between the precision of abilities is very small ($\sigma_i^2/\sigma_o^2 \to 1$), then each agent performs exactly half of the tasks. If the estimate of the incumbent's ability is very precise compared to that of the outsider ($\sigma_i^2/\sigma_o^2 \to 0$), then very little information can be learned from the incumbent, and the principal prefers to delegate all the tasks to the outsider. Naturally, in the intermediate case, the outsider performs a fraction of screening tasks strictly between 1/2 and 1.

From (7), the expected welfare of the principal can technically be divided into three terms. The first two are simply the prior expected abilities of the two agents (which are also the best estimate of their posterior expected ability) weighted by their ex-ante probabilities of being selected after the screening process. The third one is a volatility term. It reflects the fact that, when the variance in the ability of the agents increases, the expected posterior ability of the agent with highest ability also increases.[8] This is the key factor for the principal's willingness to test both agents rather than concentrate on only one of them.[9] Note also that the marginal value of splitting the screening tests is greater the closer the prior expected abilities (formally, $\frac{\partial^2 V_i^s + V_o^{n-s}}{\partial f(s)\,\partial|m_i - m_o|} < 0$). This is quite natural: if the prior abilities are sufficiently different, the agent with highest prior expected ability is most likely to keep his advantage after the revelation of information. The evaluation tasks are then going to reverse the prior ranking only with a small probability, which makes screening relatively less valuable.

2.2 Incumbent's optimal allocation of screening tasks

Clearly, the principal is the ultimate responsible for the selection of the agent which, in his view, is the most suitable one for the job. If possible, he would also prefer to decide how to allocate efficiently the screening tasks. However, it is not unusual to observe a delegation of this choice to the incumbent, due for example to principal's work overload.

[8]This is a standard property of the order statistics.

[9]In fact, $m_i\,\Phi\left(\frac{m_i - m_o}{f(s)}\right) + m_o\left[1 - \Phi\left(\frac{m_i - m_o}{f(s)}\right)\right]$ is decreasing in $f(s)$ for all m_i and m_o. This means that, absent the volatility term, the principal would find it optimal to concentrate all the tasks on the hands of one agent.

As previously noted, the interest of the agents and the principal are not aligned. Because of this discrepancy, if the principal delegates to the incumbent/senior the right to allocate the screening tasks, the choice may be different from his preferred one. Denote by s_i^* the optimal number of tasks that the incumbent wants to realize, leaving $(n - s_i^*)$ to the outsider.[10] Recall that, after the screening process, the incumbent is selected by the principal if and only if his expected posterior ability is greater than that of his opponent. Hence, the optimal number of tasks that the incumbent wants to undertake is:

$$s_i^* = \arg\max_s \; \Pr\left[E[\theta_i \,|\, X_i^s] > E[\theta_o \,|\, X_o^{n-s}]\right] \tag{8}$$

We can now characterize the optimal choice from the incumbent's viewpoint.

Proposition 2 *When the incumbent decides how to allocate the screening tasks, then:*
(i) $s_i^* = n$ *if* $m_i > m_o$.
(ii) $s_i^* \equiv \tilde{s} \in [0, n/2)$ *if* $m_i < m_o$.

Proof. From (8) and given (3) and (4), the ex-ante probability of keeping an incumbent who realizes s tasks is:

$$\Pr\left[\lambda_i^s\, m_i + \frac{1-\lambda_i^s}{s}\, X_i^s > \lambda_o^{n-s}\, m_o + \frac{1-\lambda_o^{n-s}}{n-s}\, X_o^{n-s}\right] = \Phi\left(\frac{m_i - m_o}{f(s)}\right)$$

Hence, $s_i^* = \arg\min_s f(s)$ if $m_i > m_o$ and $s_i^* = \arg\max_s f(s)$ if $m_i < m_o$.

Recall that $f''(s) < 0$. Given $\sigma_i^2 < \sigma_o^2$, then $f(0) > f(n)$. Therefore, $n = \arg\min_s f(s)$ and, as before, $\tilde{s} = \arg\max_s f(s)$. □

Suppose that the incumbent enjoys a prior advantage over his opponent because he is, on average, of higher ability ($m_i > m_o$). In this case, he wants to minimize the probability of being leapfrogged by the outsider after the observation of the outcomes in the screening tasks. In order to keep his advantage with the greatest possible probability, he will design a screening procedure that conveys the minimum amount of information.[11] As noted earlier, the informational content of each task decreases with the number of tasks previously realized. Therefore, concentrating all the tasks

[10] We could also analyze the optimal decision from the outsider's viewpoint (which in fact is symmetric). However, in general it will not make much sense to delegate the screening decision to an agent who is not even working in the firm (or to the junior employee). This is the reason why we prefer to leave that case aside.

[11] Ideally, he would even desire to suppress the screening tasks ($n = 0$): if no information ever comes, he is selected for sure. However this is ruled out because, by assumption, n is fixed.

on the hands of one agent minimizes the information revealed. Furthermore, since the ability of the incumbent is better known from the beginning than that of the outsider ($\sigma_i^2 < \sigma_o^2$), the smallest amount of information will be transmitted when it is the incumbent who realizes all these screening activities. Our theory may then partly explain why, in hierarchical organizations, being active is valuable in itself (i.e. independently of the outcome) while the actions of potential competitors are usually detrimental. Agents who are confident in their capacities will try to influence their employers by asking them: "try me" or "give me a chance".

If the incumbent lags behind the outsider, he wants to maximize the chances of leapfrogging his opponent. Given his prior handicap, this is achieved by maximizing the information revealed during the screening process (e.g. if no information ever flows in, the incumbent can never make up his disadvantage). As previously shown, maximal information is disclosed when screening tasks are split among the two agents, with fewer tasks allocated to the agent whose ability is best known. Only when the difference between the variances in abilities of the two agents is sufficiently important will the incumbent find it optimal to leave all the screening activities to the outsider. To sum up, an incumbent who realizes that he is a priori worse than the outsider will be most willing to test his rival in order to try and find his weaknesses.

Remark 1. One might wonder whether our results are driven by the assumption that the reward b for being selected is fixed (no incentive contracts allowed). If the payoff of the agent appointed were a function of his on-the-job productivity (i.e. $b(E[\theta_i])$) and the incumbent could select the allocation of screening tasks, then he would choose $s_i^{**} = \arg\max_s V_i^s$ rather than s_i^* as defined in (8). Even in that case, the objectives of the principal and the incumbent would not be aligned, so the inefficiency highlighted in the paper would still be present. In any case, the assumption of b being fixed seems quite reasonable in statutory jobs (academia and, more generally, appointments in public administrations). In these occupations, competition between agents for a promotion frequently occurs but, at the same time, pay scales are fixed.

Remark 2. In this model, screening is unproductive from the principal's viewpoint and agents are willing to perform tasks that do not yield any direct payoff. Our results would naturally remain valid if screening were intrinsically valuable for the principal and/or required some costly effort to the agents.

From Propositions 1 and 2 we can draw several general implications for organizations where the testing procedure is controlled by the incumbents. First and other things equal, high turnover rates can be a sign of efficiency. For instance, an incumbent will be replaced relatively more often if he is (on average) weaker than the outsider. However, this is precisely the situation in which the screening process is the most efficient, since only in that case the interests of the principal and the incumbents are aligned. Second, if we adopted a dynamic perspective, our model would suggest that it may not always be desirable to hire the best possible applicants. Naturally, quality affects productivity and therefore is valuable. However, it also blocks the efficiency of the (future) screening procedure, which can be costly for the organization. Last and closely related to the previous point, consider a chain of command in which a senior agent decides whether to perform a job himself or leave it to his junior colleague. Our model predicts that if the senior is, on average, relatively good, then he will perform all the tasks to avoid that the principal learns about the ability of the junior member. This result can be seen complementary to the chain of command and transmission of information argument developed in Friebel and Raith (1997).

Another result naturally follows from the previous analysis.

Corollary 1 *The welfare of both the principal and the agent with lowest prior expected ability increase in the variance of the agents' abilities (σ_i^2 and σ_o^2) and decrease in the variance of the noise (σ_ε^2). Conversely, the welfare of the agent with highest prior expected ability decreases in σ_i^2 and σ_o^2, and increases in σ_ε^2.*

Proof. Immediate if we note that $\frac{\partial f(s)}{\partial \sigma_i^2} > 0$, $\frac{\partial f(s)}{\partial \sigma_o^2} > 0$, $\frac{\partial f(s)}{\partial \sigma_\varepsilon^2} < 0$. □

Once again, both the principal and the agent with lowest ability prefer a screening process that conveys a maximum amount of information. This occurs either when the initial knowledge of the agents' ability is very imprecise, or when the signals provide very accurate information about the capacity of the individuals. The opposite reasoning is true for the agent with highest ability. Note that the interests of the principal and the agent of lowest expected ability are perfectly aligned only because the allocation of all the screening tasks is decided at the beginning of the game. If tasks were allocated sequentially (e.g. task $k+1$ were allocated after observing agent a's performance x_a^k in task k), the agent with ex-ante lowest ability would not necessarily remain the laggard all the time. Therefore, he would not necessarily keep the same interests as the principal during the whole screening process.

3 Quality of job assignments as a screening device

We now study an extended version of the model presented in Section 2. As before, the principal has to choose between two agents (incumbent/senior vs. outsider/junior) with different and partly unknown abilities. The agent selected for the job (or, equivalently, promoted) receives an exogenously fixed wage b while the other one gets 0. The agent's on-the-job productivity is equal to his ability. Contrary to Section 2, we will assume that there are only two screening tasks available ($n = 2$) and that each agent has to perform one and only one of them ($s = 1$). We will generically use the indexes $\alpha, \beta \in \{h, l\}$ (with $\alpha \neq \beta$) to denote the two available screening tasks h and l. This simplification allows us to better focus on new issues, namely those related to vertical differentiation of the screening activities and agents' incentives to perform efficiently in the screening jobs. The new features of the screening process are the following:

(i) Screening tasks are valuable, i.e. the performance of the agents in these activities enters directly in the utility function of the principal.

(ii) The performance x_a^α of agent a allocated to task α depends stochastically not only on his ability θ_a (as before) but also on his effort e_a exerted and the type of screening task α realized:

$$x_a^\alpha = \nu(\theta_a, e_a; \alpha)$$

where, for all $\bar{x} \in \mathbb{R}$: (a) $\partial \Pr\left[x_a^\alpha < \bar{x}\right] / \partial \theta_a < 0$, (b) $\partial \Pr\left[x_a^\alpha < \bar{x}\right] / \partial e_a < 0$, (c) $\Pr\left[x_a^h < \bar{x}\right] < \Pr\left[x_a^l < \bar{x}\right]$, (d) $\partial \Pr\left[x_a^h < \bar{x}\right] / \partial \theta_a < \partial \Pr\left[x_a^l < \bar{x}\right] / \partial \theta_a$ (< 0).

(iii) Both agents have the same cost of exerting effort $c(e)$, with $c' > 0$ and $c'' > 0$.

According to this formalization, performance in the screening task is likely to be higher (in a stochastic sense) the higher the agent's ability and effort (parts (a) and (b)). Furthermore, performance is also likely to be higher in task h (which stands for "high") than in task l (which stands for "low") (part (c)). Last, ability is also relatively more valuable in task h than in task l (part (d)).

The objective of the principal is twofold: first, to maximize the expected net return of the sum of the agents' performances in the screening tasks ($E[x_i^\alpha + x_o^\beta]$), and second to keep just as before the most able one for the job. By (d), then absent effort considerations the principal would find it optimal to allocate the agent with highest expected prior ability to the most valuable screening task. Formally,

$$E[\theta_i] > E[\theta_o] \;\Leftrightarrow\; \Pr\left[x_i^h + x_o^l < \bar{x} \,|\, e_a = 0\right] < \Pr\left[x_i^l + x_o^h < \bar{x} \,|\, e_a = 0\right].$$

Then, conditional on the information elicited, the agent with highest expected posterior ability would be retained for the job (and denoted w_J for "winner"). However, since different types of individuals have different incentives to work hard, this may no longer be true when effort considerations are taken into account. The objective of this section is to analyze the principal's optimal allocation of agents to the different screening tasks given this moral hazard issue. To this purpose we will analyze a game with the following timing.

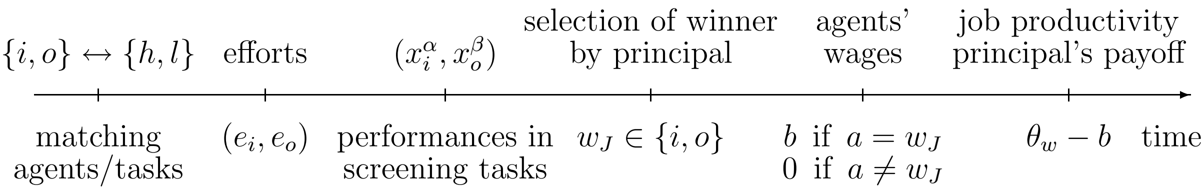

Figure 2. Timing in the "quality of job assignments" game.

Remark 3. We have assumed for symmetry with the previous section that agents do not obtain any direct reward from their performance in the screening task. Given that this activity is now intrinsically valuable, one could say that agents should get a wage b_α contingent on the type of the screening task performed. It would therefore be natural to have $b_h > b_l > 0$ so that, from the agent's viewpoint, performing task h would be preferable to performing task l, which would itself be better than not being screened by the firm. As long as these wages are not contingent on the outcome of the screening task (e.g. they are paid before the performance is observed), all the results would hold and some other insights could be gained, as we will see below.

Remark 4. Instead of screening and then selection for a job, one could easily reinterpret our setting as a two-period, job-allocation model. In this new game, two agents working in a firm (e.g., a junior and a senior) are allocated according to their ability and anticipated effort to two jobs with different productivities (h and l) and different payoffs (b_h and b_l). At the end of the first period and given their performance (x_i and x_o), there is reallocation between jobs h and l according to their updated ability.[12]

[12]Recall that none of our results change if two positions are available, as long as one of them is more attractive than the other, and the principal wants to allocate the most able agent to the most

Remark 5. The model shares many features with the two-period version of the standard career concerns literature (see e.g. the seminal paper by Holmström, 1999). By assumption, wages are not contingent on current performance. Besides, either there is no compensation for the screening task or the wage is sunk when effort is exerted. Hence, the agent has no incentives to put effort in order to increase his performance in the screening task. However, some effort might be incurred in order to bias the principal's future perception of the agent's ability. As in a rat race, this is perfectly anticipated by the principal and no bias occurs in equilibrium. One difference is that, in the standard literature, agents are paid according to their expected performance (there is perfect competition for agents) so, in equilibrium, they are full residual claimant for their effort. Instead, in our setup the agents' reward consists of being selected for the job, in which case they get the payoff b. Since their (anticipated) effort affects the perception of ability and therefore the job allocation decision, in our model agents are *partly* residual claimant for effort.[13]

The literature on career concerns has demonstrated that the specific functional form of the performance function $\nu(\cdot)$ may affect the incentives of the different types of agents to exert effort. In the next subsections, we solve our model for the two most widely used functions. In the first one, the effect of effort in the outcome of the screening task does not depend on the ability of the individual. Formally, $\partial^2 \Pr\left[x_a^\alpha < \bar{x}\right] / \partial e_a \, \partial \theta_a = 0$. In the second one, effort is more valuable the higher the ability of the individual. Formally, $\partial^2 \Pr\left[x_a^\alpha < \bar{x}\right] / \partial e_a \, \partial \theta_a < 0$.

3.1 Career concerns when ability and effort are independent

This case –which is the one analyzed in the paper by Holmström (1999) and almost all the subsequent literature– is characterized by a production function additively separable in effort and ability. The specific functional form of $\nu(\cdot)$ that we are going to adopt is:

$$x_a^\alpha = \rho_\alpha \Big[\theta_a + e_a + u_a\Big], \qquad u_a \text{ i.i.d. } \mathcal{N}(0, \sigma_u^2) \quad \text{and} \quad \rho_h > \rho_l > 0 \tag{9}$$

attractive job (which then corresponds to a promotion).

[13] Our results would not be affected in any way if we assumed that the performance of the agent selected for the job depended also on his effort. Again as in the standard career concern models, the agent in the last period (here, once in the job) has no incentives to exert effort because there is no future perception of ability to try to bias. Therefore, independently of which agent were selected, on-the-job effort would be zero. Again the important assumptions are first that the principal cannot commit on future payments, and second that rewards cannot be contingent on current effort (e.g. because effort is sunk at the time of deciding which agent is promoted).

We now proceed to a formal analysis of the game. Recall that ability is relatively more valuable in the most productive screening task, that only the outcome x_a^α (and not the effort) is observed by the principal, and that abilities are the best estimates of the agents' future productivity in the job. Hence, the principal will select for the job the agent with highest expected ability conditional on the performances and *anticipated* efforts of both agents in the screening tasks. Denote by $\tilde{e}_a$ agent a's anticipated effort. The job will then be allocated to:

$$w_J = \arg\max_{\{i,o\}} \left\{ E[\theta_i \,|\, x_i^\alpha, \tilde{e}_i], E[\theta_o \,|\, x_o^\beta, \tilde{e}_o] \right\} \tag{10}$$

Agents will have incentives to exert effort even if they are not compensated for it (or if the payoff for the screening activity is already sunk, see Remark 3). In fact, for any level of effort anticipated by the principal, exerting effort influences current performance which in turn affects the perception of ability by the principal. This is the by now well-known argument in all the literature on career concerns. Anticipating the principal's selection rule –which is given by (10)– and for a given allocation (α, β) of screening tasks, the maximization problem of the agents is:

$$\begin{aligned} e_i &= \arg\max_e \ \Pr\Big[E[\theta_i \,|\, x_i^\alpha(e), \tilde{e}_i] > E[\theta_o \,|\, x_o^\beta(e_o), \tilde{e}_o]\Big]\, b \,-\, c(e) \\ e_o &= \arg\max_e \ \Pr\Big[E[\theta_o \,|\, x_o^\beta(e), \tilde{e}_o] > E[\theta_i \,|\, x_i^\alpha(e_i), \tilde{e}_i]\Big]\, b \,-\, c(e) \end{aligned}$$

From (9) and using the same techniques as in the previous section for updating beliefs, we deduce that:

$$E[\theta_a \,|\, x_a^\alpha(e_a), \tilde{e}_a] = (1-\gamma_a)\, m_a + \gamma_a \left(\frac{x_a^\alpha(e_a)}{\rho_\alpha} - \tilde{e}_a \right) \qquad \text{where} \quad \gamma_a = \frac{\sigma_a^2}{\sigma_u^2 + \sigma_a^2} \tag{11}$$

Given (10), (11) and the fact that $x_a^\alpha(e_a) \sim \mathcal{N}\Big(\rho_\alpha(m_a + e_a), \rho_\alpha^2(\sigma_a^2 + \sigma_u^2)\Big)$, one can easily show that:

$$\begin{aligned} \Pr[\, w_J = i\,] &= \Pr\Big[E[\theta_i \,|\, x_i^\alpha(e_i), \tilde{e}_i] > E[\theta_o \,|\, x_o^\beta(e_o), \tilde{e}_o]\Big] && (12) \\ &= \Phi\left(\frac{m_i - m_o + \gamma_i(e_i - \tilde{e}_i) - \gamma_o(e_o - \tilde{e}_o)}{g(\sigma_i^2, \sigma_o^2, \sigma_u^2)} \right) && (13) \end{aligned}$$

where $g(\cdot) = \sqrt{\frac{\sigma_i^4}{\sigma_i^2+\sigma_u^2} + \frac{\sigma_o^4}{\sigma_o^2+\sigma_u^2}}$.[14] Note that (13) does not depend on ρ_h and ρ_l, that is on how agents were allocated to screening tasks. The reason is that the principal is

[14]Naturally, this function is the analogue of $f(s)$ in Section 2 to the case in which there is one observation for each agent ($s = 1$ and $n = 2$).

perfectly able to correct for the fact that, other things equal, the agent in task h is likely to exhibit a higher performance than the agent in task l.

Naturally, in equilibrium expectations must be fulfilled, that is $e_a = \tilde{e}_a$. Using (13), it is therefore immediate that equilibrium efforts $\tilde{e}_a$ are uniquely determined by:

$$c'(\tilde{e}_a) = \frac{\gamma_a}{g(\sigma_i^2, \sigma_o^2, \sigma_u^2)} \times \varphi\left(\frac{m_i - m_o}{g(\sigma_i^2, \sigma_o^2, \sigma_u^2)}\right) b. \tag{14}$$

Note that $\tilde{e}_a$ is proportional to γ_a, and therefore $\tilde{e}_o > \tilde{e}_i$. The job will eventually be offered to the incumbent/senior and to the outsider/junior with the following equilibrium probabilities:

$$\Pr[w_J = i] = \Phi\left(\frac{m_i - m_o}{g(\sigma_i^2, \sigma_o^2, \sigma_u^2)}\right) \quad \text{and} \quad \Pr[w_J = o] = \Phi\left(\frac{m_o - m_i}{g(\sigma_i^2, \sigma_o^2, \sigma_u^2)}\right)$$

By backward induction, we deduce that the high productive screening task will be executed by the agent satisfying:

$$w_S = \arg\max_{\{i,o\}} \left\{ m_i + \tilde{e}_i, m_o + \tilde{e}_o \right\} \tag{15}$$

and we can state our next result.

Proposition 3 *The high productive screening task can be allocated to the outsider or junior agent even if he is on average worse than the incumbent or senior one (i.e. even if $m_o < m_i$). This is more likely to occur, the higher b and the smaller $m_i - m_o$.*

Proof. By inspection of (14) and given that $\gamma_o > \gamma_i$, we obtain that $\tilde{e}_o > \tilde{e}_i$. Besides, $\frac{\partial(\tilde{e}_o - \tilde{e}_i)}{\partial|m_i - m_o|} < 0$ and $\frac{\partial(\tilde{e}_o - \tilde{e}_i)}{\partial b} > 0$. According to (15), $w_S = o$ if $m_o > m_i - (\tilde{e}_o - \tilde{e}_i)$. □

The incentives of agent a to bias the perception of his ability are proportional to $\gamma_a \equiv \sigma_a^2/(\sigma_a^2 + \sigma_u^2)$. Indeed, when the initial knowledge about the agent's ability is very imprecise (σ_a^2 big), the signal conveys an important amount of information. In that case, the agent has a strong interest in biasing the principal's perception of his ability, and to this purpose he exerts a great deal of effort. Formally, by (14) and given $\sigma_o^2 > \sigma_i^2$, then $\tilde{e}_o > \tilde{e}_i$. Although no bias occurs in equilibrium, this provides an advantage to the agent with most uncertain ability: since effort enters directly in the performance function $\nu(\cdot)$, this agent is sometimes selected for task h even though his expected ability is smaller than that of his rival. If agents obtain a direct payoff from undertaking task h (see Remark 3) or we interpret our model as a dynamic job-allocation game (see Remark 4), then our theory predicts that it is optimal for organizations to have a bias in favor of allocating outsiders and young employees to the best jobs. Since these agents have more to prove to their superiors than their more senior peers, they are trapped into higher levels of effort, for which the organization is residual claimant. Interestingly, these young workers will benefit from such advantage only in the short run, if at all. As Proposition 3 shows, the final selection will be efficient: even if the junior member is more likely to be allocated to task h (and receive the corresponding wage b_h in the interpretation of the model given by Remark 3), the individual eventually appointed to the job will be the one with highest expected posterior ability independently of the precision of his estimate.

From (14) and (15) we can notice that, as the difference between m_i and m_o shrinks, there are two reasons for which the outsider/junior is more likely to be allocated to the high-performance screening task. First and trivially, because his disadvantage in terms of expected quality decreases. But second and more interestingly, because the marginal incentives to exert effort are higher the closer the prior expected abilities (formally, $\varphi(x)$ is inversely proportional to $|x|$). In other words, both agents will put more effort if they are in a close race than if there is little uncertainty about who will be selected for the job after observing the screening outcomes ($\frac{\partial \tilde{e}_a}{\partial |m_i - m_o|} < 0$). Moreover, the increase in effort when the race is close will be greatest for the agent whose ability is the least known ($\frac{\partial \tilde{e}_o}{\partial |m_i - m_o|} < \frac{\partial \tilde{e}_i}{\partial |m_i - m_o|}$). Similarly, as the value of the job b increases, the incentives to put effort of both individuals –but in particular of the junior one– increase. Last, if either $\sigma_i^2 = \sigma_o^2$ or $\sigma_u^2 = 0$, then $\gamma_i = \gamma_o$. In that case, *for all* m_i *and* m_o both agents exert the same effort ($e_i = e_o$). The reason for this relies on the fact that agents exert effort according to the absolute difference in expected abilities $|m_i - m_o|$, independently of whether their own expected ability is higher or lower than that of the rival. This in turn proves that the differences in effort between the two agents are exclusively due to the differences in their incentives to bias future perception of ability, and not to the (exogenous) differences in their prior expected abilities.

3.2 Career concerns when ability and effort are complements

Dewatripont *et al.* (1999a,1999b) are the first studies in the career concerns literature that analyze a situation in which effort is more valuable the higher the ability of the individual. One of their results is the existence of multiple equilibria. If agents are expected to exert high effort, then a low performance is interpreted as the result of a low ability. This gives high incentives to exert effort in a first place. By contrast, if the anticipated effort is low, then a low performance is interpreted as the result of "bad luck" which provides low incentives to exert effort. With these premises in mind, we will analyze the following specification of the function $\nu(\cdot)$:

$$x_a^\alpha = \rho_\alpha \left[\theta_a \, e_a + u_a \right] \tag{16}$$

As in (10), the job will be allocated to the agent with highest expected ability given the performances and anticipated efforts in the screening tasks. Following again the same techniques for the updating of beliefs as in (11), we now get:

$$E[\theta_a \,|\, x_a^\alpha(e_a), \tilde{e}_a] = (1 - \mu_a(\tilde{e}_a))\, m_a + \frac{\mu_a(\tilde{e}_a)}{\rho_\alpha \, \tilde{e}_a} \, x_a^\alpha(e_a) \quad \text{where} \;\; \mu_a(\tilde{e}_a) = \frac{\tilde{e}_a^2 \, \sigma_a^2}{\sigma_u^2 + \tilde{e}_a^2 \, \sigma_a^2} \tag{17}$$

Notice that $x_a^\alpha(e_a) \;\sim\; \mathcal{N}\Big(\rho_\alpha \, m_a \, e_a, \rho_\alpha^2 (e_a^2 \, \sigma_a^2 + \sigma_u^2)\Big)$. Hence, effort affects not only the perception of the expected ability but also its variance. We can then determine the analogue of (13) to the new situation:

$$\Pr\left[\, w_J = i \,\right] = \Phi \left(\frac{m_i \frac{\sigma_u^2 + e_i \, \tilde{e}_i \, \sigma_i^2}{\sigma_u^2 + \tilde{e}_i^2 \, \sigma_i^2} - m_o \frac{\sigma_u^2 + e_o \, \tilde{e}_o \, \sigma_o^2}{\sigma_u^2 + \tilde{e}_o^2 \, \sigma_o^2}}{z(\sigma_i^2, \sigma_o^2, \sigma_u^2; \tilde{e}_i, \tilde{e}_o, e_i, e_o)} \right) \tag{18}$$

where $z(\cdot) = \sqrt{\sigma_i^4 \, \tilde{e}_i^2 \frac{\sigma_u^2 + e_i^2 \, \sigma_i^2}{(\sigma_u^2 + \tilde{e}_i^2 \, \sigma_i^2)^2} + \sigma_o^4 \, \tilde{e}_o^2 \frac{\sigma_u^2 + e_o^2 \, \sigma_o^2}{(\sigma_u^2 + \tilde{e}_o^2 \, \sigma_o^2)^2}}$.

From (18) we deduce that the marginal incentive of each agent to exert effort will depend on his own anticipated level of effort (as in Dewatripont *et al.*, 1999b) and, more importantly, on the *other agent's effort*. These are the two key differences with the previous case, in which neither the rival nor the own anticipation of effort affected the agent's willingness to work hard.

Taking the derivative with respect to effort e_a of $\Phi(\cdot)$ in (18) and given that in equilibrium expectations must be fulfilled ($\tilde{e}_a = e_a$), we get that:

$$c'(\tilde{e}_a) = \frac{\mu_a(\tilde{e}_a)}{\tilde{e}_a} \left(\frac{m_i \sigma_o^2 \mu_o(\tilde{e}_o) + m_o \sigma_i^2 \mu_i(\tilde{e}_i)}{(\sigma_o^2 \mu_o(\tilde{e}_o) + \sigma_i^2 \mu_i(\tilde{e}_i))^{3/2}} \right) \times \varphi \left(\frac{m_i - m_o}{\sqrt{\sigma_o^2 \mu_o(\tilde{e}_o) + \sigma_i^2 \mu_i(\tilde{e}_i)}} \right) b \tag{19}$$

By inspection of (19), we reach some results that are similar to the previous case. First, the agent whose ability is the most uncertain will exert the highest level of effort ($\mu_o(e) > \mu_i(e)$). Second, differences in efforts are due to differences in the incentives of agents to bias their future perception of ability and, only indirectly, to differences in prior expected abilities (for all m_i and m_o we get $\mu_o(e) = \mu_i(e)$ and therefore $\tilde{e}_o = \tilde{e}_i$ if either $\sigma_i^2 = \sigma_o^2$ or $\sigma_u^2 = 0$). The reasons are also the same. Effort affects the screening outcome. Since, the weight of performance in the estimate of the posterior expected ability is biggest for the agent with the most uncertain ability (see (17)), this individual is again more concerned than his rival with the possibility of obtaining a high performance.

We have then checked that the conclusions obtained in Section 3.1 also hold under complementarity between ability and effort. However and more importantly, in this setting we can also derive a new result.

Proposition 4 *When effort and ability are complements, there might exist multiple equilibria in which the effort of one agent depends positively on the effort of the rival.*

Proof. Let us consider a limiting case. Suppose that $\sigma_i^2 \simeq \sigma_o^2$ $(= \sigma^2)$. Then, $\mu_i(e) \simeq \mu_o(e)$ $(= \mu(e))$ and $\tilde{e}_i \simeq \tilde{e}_o$ $(= \tilde{e})$. The equilibrium condition (19) for both agents becomes:

$$c'(\tilde{e}) = \frac{m_i + m_o}{2\sigma\sqrt{2}} \frac{\sqrt{\mu(\tilde{e})}}{\tilde{e}} \varphi \left(\frac{m_i - m_o}{\sqrt{2\sigma^2 \mu(\tilde{e})}} \right) b \tag{20}$$

Note that $\lim_{\tilde{e}\to 0} \varphi \left(\frac{m_i - m_o}{\sqrt{2\sigma^2 \mu(\tilde{e})}} \right) = 0$, $\lim_{\tilde{e}\to +\infty} \varphi \left(\frac{m_i - m_o}{\sqrt{2\sigma^2 \mu(\tilde{e})}} \right) > 0$, $\lim_{\tilde{e}\to 0} \sqrt{\mu(\tilde{e})}/\tilde{e} > 0$, and $\lim_{\tilde{e}\to +\infty} \sqrt{\mu(\tilde{e})}/\tilde{e} = 0$. Therefore, the r.h.s. of (20) is always non-negative and goes to 0 as $\tilde{e}$ goes to either 0 or $+\infty$. Since $c''(\tilde{e}) > 0$, then for a suitably chosen function $c'(\tilde{e})$ we get the multiplicity result. By continuity, the argument holds for some $\sigma_i^2 \neq \sigma_o^2$. □

If one agent is expected to work hard, his updated ability will greatly depend on his performance x_a^α, and therefore he will try to bias this perception by exerting an important amount of effort. However, under complementarity between θ_a and e_a, effort also increases the variance of the performance. In other words, the harder an agent works, the more volatile the (stochastic) posterior of his expected ability. This, in turn, increases the uncertainty about who will ex-post have the greatest posterior ability. As the final outcome becomes more uncertain, the incentives to exert effort become less dependent on the prior expected abilities (m_i and m_o) and endogenously more sensitive to the performances of the two agents. To sum up, when one agent is expected to work hard, then he is trapped into fulfilling these expectations. Moreover, the outcome of his screening task becomes also more uncertain. This increases the weight of the rival's performance in the determination of who is ex-post selected for the job. Hence, the opponent is also encouraged to exert a high level of effort.

Given this multiplicity, it seems natural to study which agent will benefit from coordinating in one equilibrium or the other. From (18) we know that, given equilibrium efforts (e_o, e_i), the job will be offered to the incumbent/senior and the outsider/junior with the following ex-ante probabilities, respectively:

$$\Pr[\, w_J = i \,] = \Phi\left(\frac{m_i - m_o}{\sqrt{\sigma_o^2 \mu_o(e_o) + \sigma_i^2 \mu_i(e_i)}}\right) \quad \text{and} \quad \Pr[\, w_J = o \,] = \Phi\left(\frac{m_o - m_i}{\sqrt{\sigma_o^2 \mu_o(e_o) + \sigma_i^2 \mu_i(e_i)}}\right)$$

Now consider two possible equilibria. In the first one both agents exert low effort $e_a = \underline{e}_a$ while in the second one both agents exert high effort $e_a = \overline{e}_a$ (with $\overline{e}_i > \underline{e}_i$ and $\overline{e}_o > \underline{e}_o$). We immediately obtain the following result.

Corollary 2 *The agent with highest prior expected ability will get the job with a higher probability in the low-effort equilibrium* $(\underline{e}_i, \underline{e}_o)$ *than in the high-effort equilibrium* $(\overline{e}_i, \overline{e}_o)$*. The converse is true for the agent with lowest prior expected ability.*

Interestingly, the logic behind this corollary is quite similar to the results obtained in Section 2. In both cases, the key issue is the likelihood of keeping an ex-ante advantage relative to the likelihood of losing it. In an equilibrium with low effort by both agents, the variances of the performances in the screening tasks (and therefore the variances in the expected posterior abilities) are small. This favors the agent with a prior advantage –that is the one with the highest prior expected ability m_a– because he is most likely to keep his leading position. The opposite is true in an equilibrium where both agents exert high effort since, in that case, the agent with lowest expected ability has reasonable chances of leapfrogging his rival after the screening process. This result leads again to the conclusion that a high turnover is a sign of efficiency: if we frequently observe that the agent with ex-ante highest ability turns out to be the one with the lowest ex-post one, it means that the screening process has provided a great deal of information. This occurs when both agents exert high effort in the screening tasks, which is something valuable for the organization whenever screening is a productive activity.

4 Conclusion

From this extremely stylized model of screening and job allocation, we have been able to obtain interesting general insights. The model offers two original reasons for which, ceteris paribus, a high turnover rate might be a sign of efficiency in an organization. First, it shows that a screening process controlled by the incumbent is more efficient in organizations where incumbents are relatively weaker than outsiders, and therefore less likely to keep their insider position. Second, it argues that the agents who are ex-ante perceived as being better than their rivals are less likely to keep their advantage the greater the effort exerted by the candidates during the screening tasks. Another contribution is to show that, from a dynamic perspective and again if screening is costless but the procedure has to be delegated to the incumbent, then it may not always be optimal to hire the most capable individuals. Certainly, ability translates into performance. However, it may also lead to inefficiently low levels of information revelation during the subsequent screening processes. In other words, the expected gain in terms of on-the-job productivity of choosing the most able agent may be outweighed by the loss due to his non-alignment with the interests of the principal concerning the optimal screening procedure. Last, the model argues that organizations should optimally favor the selection of outsiders and junior agents relative to incumbents and senior ones because the former have greater implicit (career concern) incentives than the latter to perform efficiently. Note that we have imposed very little structure on our model which, in our view, strengthens our results. For example, we have assumed away any intrinsic taste for executing tasks (of the empire building type of arguments) which would have easily generated the incumbents' desire to undertake all the activities. We have also ruled out risk-aversion to avoid any exogenous incumbency/seniority advantage due to a lower degree of uncertainty in ability. Naturally, all this comes at the expense of a partial and maybe excessively simplistic modeling of screening.

Several extensions would be desirable in order to improve our understanding of the theory of screening, job allocation and relative performance evaluation. First, one could analyze the optimal sequential allocation of screening tasks. Second, it would be interesting to study competition between more than two agents.[15] And third, we could investigate a more realistic situation in which agents can be valuable at some tasks and worthless at some others. This last point would require a model with multidimensional ability.

[15] For example, if three agents compete for one job, it is relatively costless for the agent with the highest expected ability to delegate some screening tasks to the agent with lowest expected ability. This suggests that increasing the number of competitors could affect qualitatively the current results.

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