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Job Assignments, Intrinsic Motivation and Explicit Incentives

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Abstract

This paper considers the interplay of job assignments with the intrinsic and extrinsic motivation of an agent. Job assignments influence the self confidence of the agent, and thereby his intrinsic motivation. Monetary reward allow the principal to complement intrinsic motivation with extrinsic incentives. The main result is that the principal chooses an inefficient job assignment rule to enhance the agent's intrinsic motivation even though she can motivate him with monetary rewards. This shows that, in the presence of intrinsically motivated agents, it is not possible to separate job assignment decisions from incentive provision.

JEL Classification: D82, J31, J33, M12

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1 Introduction

Job assignments typically serve two purposes: to match an agent with the job for which he is most talented and to provide incentives (Baker, Jensen, and Murphy 1988). These two roles are often in conflict with each other – the rule that ensures an efficient assignment may not be the one that provides the best incentives. Therefore, the question arises why firms nevertheless use job assignments to motivate employees. Providing incentives with monetary payments only and deciding independently on assigning agents seems like a superior policy. Such a policy would avoid distortions in the allocation of agents to jobs. This argument however presumes that job assignments do not influence the motivation of an agent. As we show in this paper such a neutrality assumption is not tenable in circumstances where intrinsic motivation plays an important role.[1] Based on this insight the paper then to analyzes the interplay of job assignments with the intrinsic and extrinsic motivation of an agent.

Intrinsically motivated agents do not only care about extrinsic rewards (like monetary payments), but their motivation depends also on factors such as their self esteem or self confidence in succeeding in a task. The latter motivation source plays an important role as Pierce and Gardner (2004) point out: "an individual's self-esteem, formed around work and organizational experiences, plays a significant role in determining employee motivation". Such experiences are for examples signals by the organizational environment and significant others (Pierce and Gardner 2004). Other determinants of an employee's self confidence are job characteristics, such as task difficulty and complexity, the environment in which the task is performed, work quality, quantity and routine, as well as creativity and meaningfulness of the work, or identification with the job (Hackman and Oldham 1975, Oldham 1976, Gist and Mitchell 1992, Kreps 1997, Pierce and Gardner 2004).

All this suggests that job assignments play a crucial role for an employee's self confidence and thereby intrinsic motivation. For example, an employee perceives not getting

[1] There are many experiments which confirm that individuals are intrinsically motivated – starting with Deci (1971). Ryan, Deci, and Koestner (1999) provide a meta-analysis of existing experiments. For an economic experiment see Gneezy and Rustichini (2000). An overview of the psychologists' definitions of intrinsic and extrinsic motivation (doing something because it leads to a separable outcome) and self confidence and esteem, and how they work together, can be found in Ryan and Deci (2000) or in Leonhard, Beauvais, and Scholl (1995).

assigned to, say, a creative job as a bad signal about the employer's perception of his abilities. This decreases his self confidence and hence intrinsic motivation. The firm may therefore use job assignments strategically to influence an employee's intrinsic motivation. It seems intuitive that this can lead to distortions relative to the assignment rule that would be efficient from a pure production perspective: not all employees are well suited for a particular job, such as the one in the above example that asks for the employee's creativity. But the firm may nevertheless assign a less creative employee to such a job to increase his intrinsic motivation.

Does this also hold if the principal can additionally motivate the agent with monetary payments? One may think that an appropriately designed performance dependent bonus that compensates for lacking intrinsic motivation in a job would allow the firm to implement the production-efficient assignment rule. The main result of this paper however is that the job assignment rule (influencing the intrinsic motivation) and the bonus (influencing in our model only the extrinsic motivation) are not simple substitutes: distorting the job assignment to increase the agent's self confidence and thereby incurring production losses is cheaper than increasing the bonus to outweigh a lack in intrinsic motivation.

To show this we adopt a "looking glass self" model à la Bénabou and Tirole (2003). The principal has superior knowledge about the agent's productive abilities: she learns the "type" of an agent, while the agent only knows the prior distribution of types. The principal can assign the agent to one of two jobs. Which job assignment is production efficient depends on the type of the agent: some types are better suited for one job, some for the other. Hence, when the agent observes the assignment he tries to "look through the glasses of the principal" and infer something about his own type. In other words, the job assignment is a signal that influences the agent's self confidence about succeeding in this job. In contrast, the bonus influences only the extrinsic motivation, because the principal offers it to the agent before she learns his type. Thus, it conveys no information to the agent about his type. To derive our main result, we show that it is profit maximizing for the principal to select a separating job assignment rule. This equilibrium is characterized by a unique cutoff for assignment to the "high motivation job" (like e.g. a more creative or a more meaningful job). The cutoff is lower than the production-efficient one, i.e. places too often an agent in the high motivation job, to boost his self confidence – even though the principal can additionally motivate the agent with monetary payments in either job.

The paper is structured as follows. In the next section we discuss the related literature. Section 2 introduces the model, which is analyzed in Section 3. The last section concludes.

Related Literature

We adopt the formalization of the concepts of self confidence and intrinsic motivation introduced by Bénabou and Tirole (2003). In their model an agent has imperfect knowledge about his type and will undertake a task only if he has a high enough belief about his probability of success (defined as the agent's self confidence). The principal knows the agent's type. Since effort and ability are complements, the principal wants to enhance the agent's self confidence by choosing her instrument, a bonus. The bonus thus not only influences the motivation of the agent directly via the payoff, but also indirectly through the inference process. As the principal would like to reduce the bonus when facing a more able agent, a high bonus reduces the agent's self confidence and intrinsic motivation.

Two main differences arise between their and our model. First, in our model the job assignment influences an agent's intrinsic motivation. The bonus serves as an additional motivating channel that affects only the agent's extrinsic motivation. Second, a separation of agents by type occurs in a pure strategy equilibrium in our model, but not in theirs. The reason is that the principal's job assignment policy not only serves as a signaling device to influence the agent's self confidence, but also directly affects the principal's payoff: an inefficient assignment leads to production losses.

Ishida (2006) applies the Bénabou and Tirole (2003) framework to promotion policies, and is therefore most closely related to our model. He however does not derive the wage scheme endogenously, but assumes that the agent gets a fixed share of the output. In comparison, we show how job assignments and an endogenously derived wage scheme for each job interact.

From the large literature on careers and incentives in organizations[2] the strand that

[2]For surveys see e.g. Valsecchi (2000) and Gibbons and Waldman (1999).

is most closely related to our approach considers job assignments as an instrument for the firm to influence the information outsiders receive about an employee's ability (see e.g. Waldman 1984, Ricart i Costa 1988, Bernhardt 1995). In Waldman (1984) only the current employer observes the worker's ability, not the other firms. Job assignments therefore serve as a signal to these other firms about the agent's productivity. In comparison, in our model job assignment serve as a signal not to other firms, but to the worker himself. Furthermore, the worker has to provide unobservable effort.

A few papers address what Baker, Jensen, and Murphy (1988) describe as a puzzle: why inefficiencies in job assignments arise even though the firm can separately motivate agents with pay for performance schemes. Fairburn and Malcomson's (2001) explanation rests on nonverifiability of performance measures, offering scope for the agent to bribe the supervisor into reporting exaggerated performance to the firm. Making workers' pay contingent on their job, and supervisors' pay contingent on the firm's profits, aligns supervisors' interests more closely with those of the firm but still creates distortions in job assignments. These can go in either direction, depending on e.g. the shape of the distribution function. Koch and Nafziger (2007) provide an explanation for the non-separability of job assignments and incentive provision that is not based on contractual incompleteness: assigning an untalented agent to a high ability job makes his success very informative about effort. This helps the principal to reduce information rents in a moral hazard model, and leads to distortions in job assignments. In the current paper this effect is not present, as jobs are equally informative about effort, and distortions arise only due to differences in the intrinsic motivation across jobs.

2 The Model

There is one principal and one agent, who is risk neutral, protected by limited liability and has a reservation utility of zero. The agent can work in one of two jobs, which we call job l ("left") and job r ("right"), respectively. In each job the agent can be either successful – which generates an observable and verifiable revenue of π to the principal, or fail, which leads to a revenue of zero. The success probability depends on the agent's type $\theta \in [\theta_L, \theta_R]$, effort $e \in \{0, 1\}$ and the job, $j \in \{l, r\}$. Providing $e = 1$ costs the agent c and $e = 0$ nothing. Following Bénabou and Tirole (2003), we assume that (1) effort and the type θ are complements in the probability of success function; (2) without

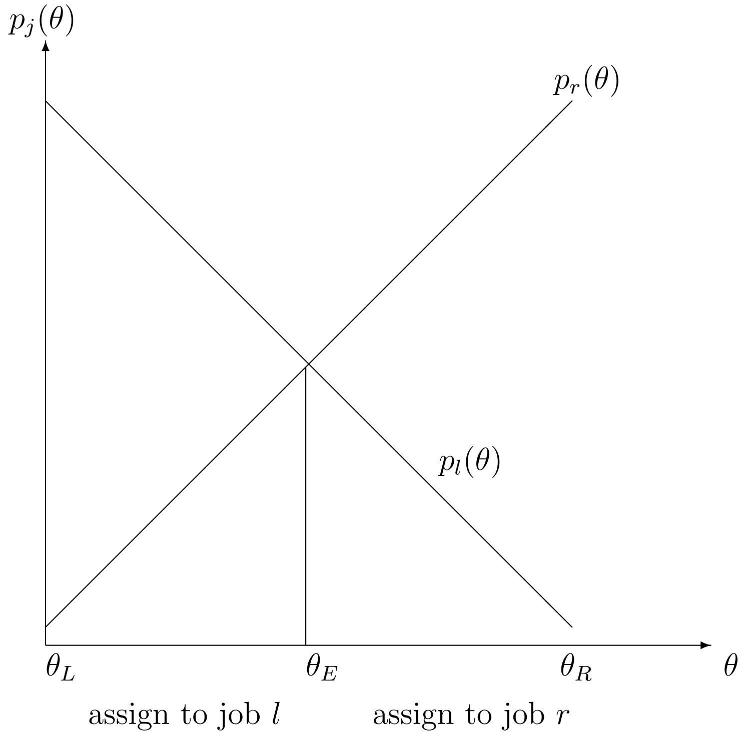

Figure 1: Example for success probabilities in job l and r and the efficient cutoff.

providing effort, the agent will fail, regardless of his talent for the job:[3]

$$p_j(\theta, e) = e\, p_j(\theta).$$

We impose the following single-crossing assumption:

Assumption 1 $\frac{dp_r(\theta)}{d\theta} > 0$ *and* $\frac{dp_l(\theta)}{d\theta} < 0$ *and* $p_r(\theta_R) > p_l(\theta_R) = p_r(\theta_L)$.

The assumption implies that there exists a unique cutoff, call it θ_E, at which the probability of success functions for the two jobs cross. Hence, it is production-efficient to assign all agents with a type lower than θ_E to job l, and all others to job r. This assumption also captures the idea that the two tasks may well be on the same level of the hierarchy, and differ only in the talents required for their specific job. As illustrated in Figure 1, agents who are more to the left of the type space are better suited for job l, and agents more to the right of the type space better suited for job r.

The timing and information structure are as follows. At date 1 the type of the agent is neither known to the principal nor to the agent. It is, however, common knowledge that

[3]Note that in contrast to Bénabou and Tirole (2003) we do not assume that $p_j(\theta)$ is linear in θ – this is just one possible special case of our more general function.

types are distributed according to the function $\Phi(\theta)$, $\Phi : [\theta_L, \theta_R] \rightarrow [0, 1]$ with density $\phi(\theta)$. At this date the principal offers a contract to the agent. Such a contract specifies a performance contingent reward scheme for each job and announces a job assignment rule $\mathcal{J} : [\theta_L, \theta_R] \rightarrow \{l, r\}$ that assigns agents depending on their type to one of the two jobs. At date 2 the principal privately learns the agent's type. For example, before starting to work in his job the agent undergoes a training phase, where he cannot judge his performance (which reveals his type), while the principal can. At date 3 the principal implements the specified job assignment rule. The agent can observe to which job he is assigned and tries to infer from this his type. Then he provides unobservable effort in the assigned job at date 4.

Following Bénabou and Tirole (2003), we restrict our attention to "bonus contracts" that reward the agent with a bonus b_j if the revenue is high in job j and pay him zero (the lower bound on payments set by limited liability) otherwise. Note that we do not give the principal the opportunity to send a message to the agent that announces his type after she learnt it. This implies that bonuses are tied to the job j rather than to individuals, which is consistent with evidence from internal labor markets (e.g. Doeringer and Piore 1971, Gibbs 1995, Koch and Peyrache 2006). Furthermore, it ensures that the bonus influences only the extrinsic motivation of an agent. Thus, in sum, a contract is a triple $\{b_1, b_2, \mathcal{J}\}$.

At the last date payoffs realize. In addition to the bonus, the agent receives some non-monetary value v ($\pi > v$, $v < c$) out of a success. This value v stands for the agent's intrinsic gain if he succeeds in completing his task: e.g. he feels proud or happy if he sees that he did a good job. We assume that the surplus is maximized when the agent provides high effort, i.e.,

Assumption 2 $p_j(\theta)(\pi + v) - c > 0 \; \forall \theta, j.$

3 Analysis

We solve for a Perfect Bayesian Equilibrium. For the analysis of the game it is important to note that every date 1-contract induces a subgame, because the principal observes the agent's type only after signing the contract. Each such subgame – the job-assignment-signaling game starting at date 2 – can be analyzed separately. Thus, beliefs for subgames that are not reached on the equilibrium path are determined by the corresponding job-assignment-signaling game equilibrium. Stated differently, the agent cannot hold "weird" beliefs that would, for example, induce him to work hard for a very low bonus if proposed a *contract* that is not offered on the equilibrium path.[4]

Thus, we can solve the game by backward induction: first we consider the incentives of an agent to provide high effort for a given bonus scheme and for a belief that is determined by the job assignment at date 3. We then investigate what job assignment rules can arise as a continuation equilibrium at date 3. As usual in a signaling game multiple equilibria can exist in this signaling game. Finally, the principal specifies bonus payments and announces a job assignment rule in the contract at date 1. We assume that the announcement acts as a coordination device on a particular continuation equilibrium: the principal will announce – among the other possible equilibrium rules – the profit maximizing job assignment rule at date 1. This enables us to derive a unique profit maximizing contract that the principal selects in equilibrium at date 1.

Incentives to Provide Effort

When the agent makes his effort choice at date 4 he does not know his success probability for sure. He is however aware of the fact that the principal learnt the agent's type after signing the contract and that she uses this information for the job assignment. Thus, the agent holds a posterior belief $E[p_j(\theta)|\mathcal{J}] \equiv \mu_j(\mathcal{J})$ about his success probability. As the bonus is tied to the job it is only the job assignment that conveys information about the agent's type. The agent hence takes the principal's perspective and learns from her chosen assignment about himself. For example, if he is assigned to job l, and knows that the principal assigns only agents with a type below a certain threshold to job l, he infers that his type falls below this threshold and updates his beliefs accordingly. Bénabou and Tirole (2003) refer to this process as the "looking glass self" phenomenon.

Given his beliefs and the job attached bonus, b_j, the agent will provide high effort if and only if:

$$\mu_j(\mathcal{J})\,(b_j + v) - c \geq 0. \tag{1}$$

This incentive constraint shows that the agent's motivation comes from two endogenous sources: his self confidence and the bonus. While the bonus is an extrinsic motivator, his self confidence is an intrinsic motivator. If the agent is more confident in succeeding,

[4]Still any beliefs are allowed in the job-assignment-signaling game for *jobs* not offered in equilibrium.

he is willing to work harder for the same bonus. As the job assignment rule influences the agent's self confidence, the principal can strategically use the assignment policy to boost the agent's self confidence and thus save on monetary rewards. Such a policy however may call for assigning the agent to a job for which he is not well suited and can therefore lead to lower revenues. The aim of the next sections is to explore this trade-off further and establish under what conditions the savings on monetary rewards outweigh the revenue loss.

The Job Assignment Signaling Subgames

As a first step we analyze the job assignment decision that the principal carries out at date 3 for a given contract already in place. At this stage she has already learnt the agent's type and thus the job assignment serves as a signal of this information. As usual in a signaling game multiple equilibria may emerge. The principal can either assign all types to the same job j (pooling equilibrium); or some types to job l and others to job r (separating equilibrium). We now explore under which conditions we can support either of these equilibria in a job-assignment-signaling (sub)game starting at date 3. In the next section we then ask which of these equilibria is profit maximizing and will hence be announced with the contract by the principal at date 1.

We first consider the existence of separating equilibria given the bonuses b_l and b_r, which the principal specifies at date 1. We can characterize such equilibria by cutoff(s) θ_S: the principal assigns an agent whose type falls short of θ_S to job l and the others to job r. Hence, the agent holds a belief $\mu_l(\theta_S) = E[p_l(\theta)|\theta \leq \theta_S]$ when assigned to job l, and $\mu_r(\theta_S) = E[p_r(\theta)|\theta \geq \theta_S]$ in job r.

Lemma 1 *Given (b_l, b_r) separating equilibria exist if and only if*

1. *there exists a θ_S, such that $p_l(\theta_S)(\pi - b_l) = p_r(\theta_S)(\pi - b_r)$ and $b_j \geq \frac{c}{\mu_j(\theta_S)} - v \,\forall\, j$.*
2. *there exists a θ_S, such that $b_j < \frac{c}{\mu_j(\theta_S)} - v \,\forall\, j$.*

There does not exist a separating equilibrium in which the agent works in one job and shirks in the other.

The first part characterizes a separating equilibrium in which the agent works hard in any job. In such the principal must be indifferent for the last type assigned to job l – θ_S – between assigning him to job l or r: $p_l(\theta_S)(\pi - b_l) = p_r(\theta_S)(\pi - b_r)$. The second part characterizes an equilibrium in which the agent never works. Finally, the last part shows that there cannot exist a separating equilibrium in which the agent works hard in one job, but not in the other: the principal always had an incentive to deviate from such a rule and assign the agent to the job in which he would work hard. Within a job the principal cannot discriminate among different types (e.g. letting some work hard and some shirk) as the bonus does not condition on the agent's type.

We next consider the existence of pooling equilibria. In a pooling equilibrium in which the principal assigns all types to job l (i.e. $\theta_S = \theta_R$) the agent beliefs to succeed with $\mu_l(\theta_R) = E[p_l(\theta)|\theta \leq \theta_R] = E[p_l(\theta)]$. For a job r pooling equilibrium this belief is $\mu_r(\theta_L)$. If the principal assigns the agent in a job j pooling equilibrium to job i we are free to pick the out-of-equilibrium belief $\tilde{\theta}$.

Lemma 2 *Given (b_l, b_r) pooling equilibria on job i exist if and only if*

1. $b_i \geq \frac{c}{\mu_i(\theta_j)} - v$ *and it exists a* $\tilde{\theta}$, *such that* $b_j \geq \frac{c}{p_j(\tilde{\theta})} - v$, *but* $p_i(\theta)(\pi - b_i) > p_j(\theta)(\pi - b_j)\forall\theta$.

2. $b_i \geq \frac{c}{\mu_i(\theta_j)} - v$ *and it a* $\tilde{\theta}$, *such that* $b_j < \frac{c}{p_j(\tilde{\theta})} - v$.

3. $b_i < \frac{c}{\mu_i(\theta_j)} - v$ *and it a* $\tilde{\theta}$, *such that* $b_j < \frac{c}{p_j(\tilde{\theta})} - v$.

The first part characterizes a pooling equilibrium in which the agent works hard in job i and also if he would be assigned to job j. The principal has no incentive to deviate and assign him to the other job, because her profits from doing so would be lower. The second part identifies an equilibrium in which the agent would not work hard if assigned to job j instead of job i. Finally, one can support a pooling equilibrium in which the agent shirks in job i and does so also if the principal would assign him to job j.

Based on Lemma 1 and 2 we show in the appendix that for any (b_l, b_r) an equilibrium in pure strategies in the subgame starting at date 2 exists.

The Optimal Contract: the Interplay between Intrinsic Motivation, Job Assignments and the Bonus

At date 1 the principal designs the bonuses and announces the job assignment rule that maximizes her profits. Note that the incentive and limited liability constraints ensure that the agent receives a weakly positive rent given the bonus and his belief that is induced by the announced assignment rule at date 1. Thus, in equilibrium the agent will participate in the relationship.

We proceed as follows: first we identify the profit maximizing separating equilibrium, then the pooling equilibrium, before we ask whether the principal wants to pool or separate the types.

Profit maximizing separating equilibrium At date 1 the principal maximizes her profits over bonuses and the effort she wants the agent to provide. Furthermore, she specifies in the contract the job assignment rule she will implement at date 3. Out of all possible separating equilibria she will select the one that maximizes her profits. We will first consider those equilibria where the agent works hard in any job. Formally the problem of the principal looks then as follows:

$$\begin{array}{ll} \max_{b_l, b_r, \theta_S} & \Phi(\theta_S)\, \mu_l(\theta_S)\, (\pi - b_l) + (1 - \Phi(\theta_S))\, \mu_r(\theta_S)\, (\pi - b_r), \\ \text{s.t.} & \mu_l(\theta_S)\, (b_l + v) - c \geq 0, \\ & \mu_r(\theta_S)\, (b_r + v) - c \geq 0, \\ & p_l(\theta_S)\, (\pi - b_l) - p_r(\theta_S)\, (\pi - b_r) = 0. \end{array} \tag{2}$$

Given the principal wants to implement high effort, she maximizes her expected profits over the cutoff θ_S and bonuses (b_l, b_r). When doing so she has to take into account the following constraints: the first two constraints require that it must be optimal for the agent to provide indeed high effort given the bonus b_j and the belief $\mu_j(\theta_S)$. The third constraint characterizes the separating equilibrium: given bonuses b_l and b_r there need to exists a cutoff θ_S at which the principal is indifferent between assigning the agent to job l or job r.

The following proposition shows that there exists a unique solution to this problem:

Proposition 1 *The profit maximizing separating equilibrium is characterized by:*

1. *Bonuses* $b_l = b_l(\theta_S)$ *and* $b_r = b_r(\theta_S)$*, where* $b_j(\theta_S) = \frac{c}{\mu_j(\theta_S)} - v$.
2. *A unique cutoff* $\theta_S \neq \theta_E$*, satisfying* $p_l(\theta_S)(\pi - b_l(\theta_S)) = p_r(\theta_S)(\pi - b_r(\theta_S))$.
3. *If and only if* $\mu_l(\theta_E) < \mu_r(\theta_E)$*:*
   - *(i) Fewer agents than efficient are assigned to job* l*, i.e.* $\theta_E > \theta_S$.
   - *(ii) The agent has a higher self confidence in job* r *than in* l*:* $\mu_l(\theta_S) < \mu_r(\theta_S)$.
   - *(iii) The bonus in job* l *is higher than in job* r*:* $b_l(\theta_S) > b_r(\theta_S)$.

Part 1 of the proposition shows that the optimal bonuses make the incentive constraint just binding for a given cutoff. Part 2 shows that this profit maximizing cutoff is not the production efficient one: while the principal has the possibility to implement the efficient cutoff by setting $b_l = b_r$ she chooses not to do so. This can explain a seemingly puzzling observation: why do firms not separate job assignments from the provision of incentives (Baker, Jensen, and Murphy 1988)? Using job assignments as a motivator leads to inefficiencies (e.g. the Peter Principle), which could be avoided if the firm leaves the provision of incentives to pay for performance schemes. The presence of intrinsically motivated agents makes such a separation impossible. The job assignment influences the agent's self confidence and hence his incentives: the proposition shows that distorting the cutoff to increase the agent's self confidence is cheaper than increasing the bonus.

To outline the intuition behind this result, we focus on the case where the agent's self confidence at the efficient cutoff is higher in job r than l: $\mu_l(\theta_E) < \mu_r(\theta_E)$. We call such a job in which the self confidence is higher, the "high motivation job". For example, the work quality in job r might be better than in job l and thus the agent beliefs to succeed with a higher probability. According to Part 3 of the proposition this implies that the principal assigns more types than efficient to the high motivation job: $\theta_S < \theta_E$. The driving force behind the distortion is the following: a higher motivation results in a lower bonus that makes the incentive constraint binding in job r compared to job l as Part 3 (iii) shows. Thus, assigning more types to the high motivation job helps to reduce the expected wage bill.

But such a policy also reduces the expected revenues as some types close to the cutoff would be more productive in job l. If the principal implemented the efficient cutoff no such production losses occurred. To support θ_E as the cutoff in a separating equilibrium she however has to increase b_r, such that $b = b_r = b_l = b_l(\theta_E) > b_r(\theta_E)$. That is, she has to leave the incentive constraint in job r slack. Moreover, the bonus b is higher than the ones described in the proposition: $b = b_l(\theta_E) > b_l(\theta_S) > b_r(\theta_S) > b_r(\theta_E)$, because the self confidence in job r (l) is an increasing (decreasing) function in the cutoff (see Equations 4 and 5 in the appendix). Thus, to implement the efficient cutoff the principal has to pay a higher bonus not only in job r, but also in job l. The proposition shows that the principal distorts the cutoff, because the gain – lower bonuses – outweighs the losses in production the distortion brings along.

Note however that assigning more types to the high motivation job decreases the self confidence in this job. The principal takes this decrease into account, because the agent is still more motivated in job r than in the low motivation job ($\mu_l(\theta_S) < \mu_r(\theta_S)$ according to Part 3 (ii)). Moreover, the principal cannot gain from the higher self confidence in job r at θ_E: to implement θ_E she had to *increase* b_r away from $b_r(\theta_S)$, such that $b_r = b_l = b_l(\theta_E)$. Thus, even though the self confidence at θ_E in job r is higher than at θ_S the bonus would be higher at θ_E.

So far we considered only the case where it is optimal for the principal to implement high effort in both jobs. If she would implement low effort in both jobs her profits would be zero and therefore strictly lower than for high effort. Thus, it is indeed optimal to implement high effort. As shown in Lemma 1 there does not exist a separating equilibrium in which the agent works in one job and not in the other as the principal always has an incentive to deviate from such a rule and assign an agent to the job in which he would work hard.

Profit maximizing pooling equilibrium We next consider pooling equilibria. If the principal pools on job j, the agent holds the belief $\mu_j(\theta_i)$ about his success probability: the assignment rule conveys no further information. To induce the agent to work hard she pays the lowest bonus that satisfies the incentive constraint $b_i(\theta_i) = \frac{c}{\mu_i(\theta_j)} - v$. This results in profits $p_i(\theta)\left(\pi + v - \frac{c}{\mu_i(\theta_j)}\right)$. Hence, the profit maximizing pooling equilibrium assigns all agents to job i if and only if

$$\mu_i(\theta_j) \geq \mu_j(\theta_i) \leftrightarrow Ep_i(\theta) \geq Ep_j(\theta). \tag{3}$$

Profit maximizing equilibrium Lastly, we have to consider whether the principal would like to choose the profit maximizing pooling equilibrium or the separating equilibrium:

Proposition 2 *The profit maximizing separating equilibrium leads to strictly higher profits than the profit maximizing pooling equilibrium.*

Separation of types by jobs creates differences in the work motivation across the jobs: agents in the low motivation job have a lower self confidence than those in the high motivation job. Pooling all agents on a job could avoid these differences. The price is however a large loss in revenues as much more agents work in a job for which they are not well suited. Differentiating the agents by jobs in the separating equilibrium allows the principal to fine tune this trade-off: she reduces – but does not remove completely – the differences in self confidence across jobs compared to an efficient assignment ($\mu_r(\theta_S) - \mu(\theta_S) < \mu_r(\theta_E) - \mu(\theta_E)$) by distorting the cutoff a little bit. Thus, differentiation of intrinsically motivated employees by jobs is optimal if this has a positive effect on the revenue component in the profit function.

4 Conclusion

Differences in the intrinsic motivation across jobs lead to inefficient job assignments. Although the principal can outweigh the lower motivation with a higher bonus and reduce the distortion in the cutoff, she chooses not to do so. This shows that in the presence of intrinsically motivated agents it is not possible to separate the role of job assignments from the role of incentive provision – leaving the latter to pay for performance schemes, because the assignment influences the self confidence of employees.

Appendix

Proof (Lemma 1 and 2).

We divide the bonus space in the following ranges and check for each combination of ranges of b_1 and b_2 whether a pure strategy pooling or separating equilibrium exists.

For pooling equilibria we denote the out-of-equilibrium belief by $\tilde{\theta}$. In a job l pooling equilibrium the agent holds a belief $\mu_l(\theta_R)$ and if the principal pools the types on job r this belief is $\mu_r(\theta_L)$. In a separating equilibrium the agent believes when assigned to job l (r) that his success probability is $\mu_l(\theta_S)$, where $\mu_l(\theta_S) \in (\theta_R, \mu_l(\theta_R))$ depending on θ_S ($\mu_r(\theta_S) \in (\theta_L, \mu_r(\theta_L))$).

1. $b_l < \frac{c}{\theta_R} - v$: the incentive constraint in job l is violated for all types (and beliefs).
2. $b_l \in \left[\frac{c}{\theta_R} - v, \frac{c}{\mu_l(\theta_R)} - v\right)$: the incentive constraint in job l is satisfied for beliefs $\mu_l(\theta_S) \in (\theta_L, \mu_l(\theta_R))$.
3. $b_l \geq \frac{c}{\mu_l(\theta_R)} - v$: the incentive constraint in job l is satisfied for beliefs that are larger than $\mu_l(\theta_R)$.
4. $b_r < \frac{c}{\theta_L} - v$: the incentive constraint in job r is violated for all types (and beliefs).
5. $b_r \in \left[\frac{c}{\theta_L} - v, \frac{c}{\mu_r(\theta_L)} - v\right)$: the incentive constraint in job r is satisfied for beliefs $\mu_r(\theta_S) \in (\theta_L, \mu_r(\theta_L))$.
6. $b_r \geq \frac{c}{\mu_r(\theta_L)} - v$: the incentive constraint in job r is satisfied for beliefs that are larger than $\mu_r(\theta_L)$.

We now check for each range whether a pooling or separating equilibrium can exist:

1. Suppose bonuses are such that Condition 1 and 5 hold (analogue 2 and 4). We cannot support a separating equilibrium in which the types assigned to job r provide high effort and the ones to job l low effort: the principal had an incentive to deviate and assign those who are assigned to job l to job r as they would then provide effort.

   We can support a pooling equilibrium on job r where no agent provides effort: for this we have to assign the agent an out-of equilibrium belief of e.g. $\tilde{\theta} = \theta_R$. This implies that the agent does not provide high effort when assigned to job l and hence the principal has no incentive to deviate.

2. Suppose that Condition 2 and 5 hold. If there exists a θ_S, such that $p_r(\tilde{\theta}_S)(\pi - b_r) = p_l(\tilde{\theta}_S)(\pi - b_l)$ and $b_i \geq \frac{c}{\mu_i(\theta_S)}$ we can support a separating equilibrium.

   If there exists no such $\tilde{\theta}_S$, then we can still construct a pooling equilibrium in which no agent provides high effort (analogue to Point 1.).

3. Suppose bonuses are such that Condition 1 and 4 hold. Then either pooling or separating can be an equilibrium (or we can support hybrid equilibria): under all possible assignments (on or off the equilibrium path) the agent provides low effort. Hence, the principal's profits are zero and she is indifferent to which job she assigns an agent.

4. Suppose bonuses are such that Condition 3 and 6 hold. Given our continuity and monotonicity assumptions for any (b_l, b_r) either $p_l(\theta)(\pi - b_l) > p_r(\theta)(\pi - b_r)$ $\forall\theta$, or $p_r(\theta)(\pi - b_r) > p_l(\theta)(\pi - b_l)$ $\forall\theta$ holds, or there exists a unique $\hat{\theta} \in (\theta_L, \theta_R)$, such that $p_r(\hat{\theta})(\pi - b_r) = p_l(\hat{\theta})(\pi - b_l)$.

   In the first case a job l pooling equilibrium can be supported ($\theta_S = \theta_R$): either one can find a $\tilde{\theta}$, such that $b_r \geq \frac{c}{p_r(\tilde{\theta})} - v$, i.e. the agent provides high effort even when assigned to job r instead of job l. Here the condition $p_l(\theta)(\pi - b_l) > p_r(\theta)(\pi - b_r)$ $\forall\theta$ states that in this case profits are higher in job l than in job r. Hence, the principal has no incentive to deviate and assign the agent to job r. Or $b_r < \frac{c}{p_r(\tilde{\theta})} - v$ – in this case the agent does not provide high effort in job r and again the principal has no incentive to deviate.

   In the second case (analogue to the first case) a job r pooling equilibrium ($\theta_S = \theta_L$) and in the third a separating equilibrium exists.

5. Suppose bonuses are such that Condition 1 and 6 hold (analogue 3 and 4). Then we can support a job r pooling equilibrium: we can find an out-of-equilibrium belief $\tilde{\theta}$ such that the agent does not provide high effort in job l. Condition 6 states that the agent provides high effort in job r given the principal assigns all agents to this job. Hence, the principal has no incentive to deviate and assign the agent to job l instead of 2.

6. Suppose bonuses are such that Condition 2 and 6 hold (3 and 5). Then we can either support a separating equilibrium (see Point 2.) or a pooling equilibrium (see Point 5.)

■

Proof Proposition 1.

We first start by showing some preliminary results about the properties of the minimal bonus that satisfies the incentive constraint. Those will be useful when proving the proposition. First, the derivative of the posterior beliefs are given by:

$$\frac{\partial \mu_r(\theta_S)}{\theta_S} = \frac{\phi(\theta_S)}{1 - \Phi(\theta_S)}[\mu_r(\theta_S) - p_r(\theta_S)] > 0, \tag{4}$$

$$\frac{\partial \mu_l(\theta_S)}{\theta_S} = \frac{\phi(\theta_S)}{\Phi(\theta_S)}[p_l(\theta_S) - \mu_l(\theta_S)] < 0. \tag{5}$$

In the following we consider the case $\mu_l(\theta_E) < \mu_r(\theta_E)$ – the other one is analogue.

Define the bonus that satisfies the incentive constraint with equality as:

$$b_i(\theta_S) = \frac{c}{\mu_i(\theta_S)} - v. \tag{6}$$

From Equation 4 and 5 it then follows that:

$$\frac{\partial b_l(\theta_S)}{\partial \theta_S} > 0 \quad \text{and} \quad \frac{\partial b_r(\theta_S)}{\partial \theta_S} < 0. \tag{7}$$

Define the function $w(\theta_S) = b_l(\theta_S) - b_r(\theta_S)$. This is an increasing and continuous function in θ_S. Furthermore, $b(\theta_E) > 0$ given $\mu_l(\theta_E) < \mu_r(\theta_E)$ and $b(\theta_L) < 0$. Hence, by the Intermediate Value Theorem, there exists a unique θ, call it θ_W, such that the bonuses are equal: $b(\theta_W) = 0$. Note that $\theta_W \in (\theta_L, \theta_E)$ for $\mu_l(\theta_E) < \mu_r(\theta_E)$ and $\theta_W \in (\theta_E, \theta_R)$ for $\mu_l(\theta_E) > \mu_r(\theta_E)$.

We proceed as follows: we first show that the incentive constraint needs to be binding in at least one job (Part 1). From this we are then able to prove in Part 2 the first and second part of the proposition: it is optimal to choose a cutoff that implies that both incentives constraints are binding. Based on this we show in Part 3 the properties of the optimal cutoff, self confidence and bonuses (the third part of the proposition).

Part 1: $b_j > b_j(\theta_S)\ \forall j$ can never be optimal

In this part we show that setting $b_j > b_j(\theta_S)$ for both jobs cannot be optimal. For this we proceed as follows: we first ask whether setting $b_l \neq b_r$ can be optimal in such a situation (Steps 1 and 2 below). We conclude that it cannot, i.e. if the incentive constraint is not binding in both jobs we must have $b_l = b_r$. Step 3 then shows also $b_l = b_r$ and slack incentive constraints cannot be optimal. We conclude that it cannot be profit maximizing to leave the incentive constraint slack in both jobs.

1. Suppose that $b_l < b_r$. For $p_l(\theta_S)(\pi - b_l) - p_r(\theta_S)(\pi - b_r) = 0$ (which we call in the following the indifference condition) to hold we must have $\theta_S > \theta_E$. Reduce instead b_r, such that $b_l = b_r$. This induces the cutoff θ_E. The incentive constraint is still satisfied: $b_l = b_r > b_r(\theta_S) > b_r(\theta_E)$ and $b_r(\theta_E) > b_l(\theta_E)$. Thus, $b_l < b_r$ cannot be optimal.

2. Suppose that $b_r < b_l$. For the indifference condition to hold we must have $\theta_S < \theta_E$. Reduce instead b_l marginally, leaving b_r unchanged. This increases θ_S and hence $b_l(\theta_S)$, but still $b_l > b_l(\theta_S)$. Thus, $b_l > b_r$ cannot be optimal.

3. So suppose $b_l = b_r$. This implies $\theta_E = \theta_S$. Then $b_l(\theta_E) < b_r(\theta_E) < b_l = b_r$ (given $\mu_l(\theta_E) < \mu_r(\theta_E)$). But setting $b_l = b_r = b_r(\theta_E)$ leads to higher profits.

Thus, it follows that the we must have $b_i = b_i(\theta_S)$ and $b_j \geq b_j(\theta_S)$ given the agent should work hard. We consider in the following the case where $b_l = b_l(\theta_S)$. The other one is analogue.

Part 2: $b_l = b_l(\theta_S)$ and $b_r \geq b_r(\theta_S)$

We proceed as follows: we first identify the bonus in job r that is induced from the indifference condition given that $b_l = b_l(\theta_S)$ (Step 1). We then ask under which conditions this bonus satisfies the incentive constraint in job r and identify a unique cutoff up to which it does (Step 2). We then show that it is profit maximizing to choose exactly the cutoff where the implied bonus in job r satisfies the incentive constraint (Step 3).

1. From the indifference condition it follows that given $b_l = b_l(\theta_S)$ the bonus in job r must satisfy:

$$\tilde{b}_r(\theta_S) = \frac{p_r(\theta_S) - p_l(\theta_S)}{p_r(\theta_S)}\,\pi + \frac{p_l(\theta_S)}{p_r(\theta_S)}\,b_l(\theta_S). \tag{8}$$

2. Does the agent provide high effort given this bonus, i.e. $\tilde{b}_r(\theta_S) \geq b_r(\theta_S)$? To see this define:

$$g(\theta_S) = \tilde{b}_r(\theta_S) - b_r(\theta_S) = \frac{p_r(\theta_S) - p_l(\theta_S)}{p_r(\theta_S)}\,\pi + \frac{p_l(\theta_S)}{p_r(\theta_S)}\,b_l(\theta_S) - b_r(\theta_S) \tag{9}$$

   Suppose $\mu_l(\theta_E) < \mu_r(\theta_E)$ and hence $\theta_W \in (\theta_L, \theta_E)$ (the other case is analogue). The latter implies that $p_r(\theta_W) < p_l(\theta_W)$. Furthermore by the definition of θ_W we have $b_l(\theta_W) = b_r(\theta_W)$. Thus, $g(\theta_W) < 0$. Furthermore, $g(\theta_E) > 0$ because $b_l(\theta_E) > b_r(\theta_E)$ and $p_r(\theta_E) = p_l(\theta_E)$. Lastly, $\frac{\partial g(\theta_S)}{\partial \theta_S} > 0$ as $b_l(\theta_S)$ is increasing in θ_S, $b_r(\theta_S)$ is decreasing and:

$$\frac{p_l'(\theta_S)\,p_r(\theta_S) - p_r'(\theta_S)\,p_l(\theta_S)}{(p_r(\theta_S))^2}\,(b_l(\theta_S) - \pi) > 0. \tag{10}$$

   Hence, by the Intermediate Value Theorem there exists a unique $\hat{\theta}_S \in (\theta_W, \theta_E)$ such that $g(\hat{\theta}_S) = 0$. Thus, if the incentive constraint in job l is binding we must have that $\theta_S \in [\theta_L, \hat{\theta}_S]$, such that the agent provides effort when assigned to job r.

3. To see which cutoff in the interval $[\theta_L, \hat{\theta}_S]$ is optimal we consider the principal's profit function evaluated at bonuses $b_l(\theta_S)$ and $\tilde{b}_r(\theta_S)$:

$$\Pi(\theta_S) = \Phi(\theta_S)\,\mu_l(\theta_S)\,(\pi - b_l(\theta_S)) + (1 - \Phi(\theta_S))\,\mu_r(\theta_S)\left(\pi - \tilde{b}_r(\theta_S)\right). \tag{11}$$

This is a strictly increasing function in θ_S:

$$\begin{aligned}
\frac{\partial \Pi(\theta_S)}{\partial \theta_S} &= -\Phi(\theta_S)\, \mu_l(\theta_S)\, b_l'(\theta_S) \\
&\quad + (1-\Phi(\theta_S))\, \mu_r(\theta_S) \left[(b_l(\theta_S)-\pi)\frac{p_l'(\theta_S)p_r(\theta_S)-p_r'(\theta_S)p_l(\theta_S)}{(p_r(\theta_S))^2} + b_l'(\theta_S)\frac{p_l(\theta_S)}{p_r(\theta_S)}\right] \\
&\quad + \phi(\theta_S)\,[p_l(\theta_S)-\mu_l(\theta_S)]\,[\pi - b_l(\theta_S)] + \phi(\theta_S)\,[\mu_r(\theta_S)-p_l(\theta_S)]\,[\pi-\tilde{b}_r(\theta_S)] \\
&\quad + (\pi - \tilde{b}_r(\theta_S))\,\mu_r(\theta_S)\,\phi(\theta_S) - (\pi - b_l(\theta_S))\mu_l(\theta_S)\,\phi(\theta_S) \\
&= -b_l'(\theta_S)\left[\Phi(\theta_S)\,\mu_l(\theta_S) - (1-\Phi(\theta_S))\,\mu_r(\theta_S)\,\frac{p_l(\theta_S)}{p_r(\theta_S)}\right] \\
&\quad + \Phi(\theta_S)\,\mu_r(\theta_S)\,[b_l(\theta_S)-\pi]\frac{p_l'(\theta_S)p_r(\theta_S)-p_r'(\theta_S)p_l(\theta_S)}{(p_r(\theta_S))^2} > 0.
\end{aligned} \tag{12}$$

Where we used the indifference condition and $\theta_S \in [\theta_L, \hat{\theta}_S]$, with $\hat{\theta}_S > \theta_W$. Hence, the principal sets $\theta_S = \hat{\theta}_S$, which is highest possible cutoff consistent with these bonuses. Thus, $b_r = b_r(\theta_S)$.

Part 3: properties

Above we showed that for $\mu_l(\theta_E) < \mu_r(\theta_E)$ we have that $\theta_S = \hat{\theta}_S \in (\theta_W, \theta_E)$. Using Equation 4 and 5 and $\theta_W < \theta_S < \theta_E$ implies that then $\mu_l(\theta_E) < \mu_l(\theta_S) < \mu_r(\theta_S) < \mu_r(\theta_E)$. As bonuses are inversely related to the belief $\mu_j(\theta_S)$ it follows that $b_l(\theta_S) > b_r(\theta_S)$. ■

Proof Proposition 2.

Assume $\theta_S > \theta_E$, i.e. $\mu_l(\theta_S) > \mu_r(\theta_S)$ (the other case is analogue). The principal prefers the separating job assignment rule to one that pools the agents if and only if:

$$(\pi + v)\left(\int_{\theta_L}^{\theta_S} p_l(\theta)\phi(\theta)d\theta + \int_{\theta_S}^{\theta_R} p_r(\theta)\phi(\theta)d\theta\right) - c \geq (\pi+v)\int_{\theta_L}^{\theta_R} p_i(\theta)\phi(\theta)d\theta - c, \tag{13}$$

or if and only if:

$$\int_{\theta_L}^{\theta_S} p_l(\theta)\phi(\theta)d\theta + \int_{\theta_S}^{\theta_R} p_r(\theta)\phi(\theta)d\theta \geq \int_{\theta_L}^{\theta_R} p_i(\theta)\phi(\theta)d\theta. \tag{14}$$

Suppose first that $\int_{\theta_L}^{\theta_R} p_l(\theta)\phi(\theta)d\theta > \int_{\theta_L}^{\theta_R} p_r(\theta)\phi(\theta)d\theta$. Then Condition 14 holds if and only if: $\int_{\theta_L}^{\theta_S}(p_r(\theta)-p_l(\theta))\phi(\theta)d\theta \geq 0$. Furthermore, $\mu_l(\theta_S) > \mu_r(\theta_S) \leftrightarrow \frac{1}{\Phi(\theta_S)}\int_{\theta_L}^{\theta_S} p_l(\theta)\,\phi(\theta)d\theta > \frac{1}{1-\Phi(\theta_S)}\int_{\theta_S}^{\theta_R} p_r(\theta)\,\phi(\theta)d\theta$. But $\frac{1}{1-\Phi(\theta_S)}\int_{\theta_S}^{\theta_R} p_r(\theta)\,\phi(\theta)d\theta > \frac{1}{\Phi(\theta_S)}\int_{\theta_L}^{\theta_S} p_r(\theta)\,\phi(\theta)d\theta$. Hence, Condition 14 holds.

Suppose now that $\int_{\theta_L}^{\theta_R} p_l(\theta)\phi(\theta)d\theta \leq \int_{\theta_L}^{\theta_R} p_r(\theta)\phi(\theta)d\theta$, then Condition 14 can hold only if and only if: $\int_{\theta_S}^{\theta_R}(p_l(\theta)-p_r(\theta))\phi(\theta)d\theta \geq 0$. Note that $\theta_S > \theta_E$. Hence, we have $p_r(\theta) < p_l(\theta)\ \forall\theta \in [\theta_S, \theta_R]$ and this is always satisfied. ■

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