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JOB DESIGN AND THE BENEFITS OF PRIVATE TRADE

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Abstract

We reconsider the job design theory of Holmstrom and Milgrom (1991), to include career concerns considerations. When reputations are considered, discretion may play a more integral part of the incentive scheme. It can be a useful instrument to enhance incentives and prevent the adverse selection of low ability agents. We then show that these synergies are useful in explaining the employment of U.S. faculty members and the employment of agents in the English East India Company, an historically important firm.

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1 Introduction

The study of multitask principal-agent models owes a great deal to the seminal work of Holmstrom and Milgrom (1991, 1994). By addressing the allocation of agents' effort across a range of tasks they expand the standard principal-agent model to analyze a wide array of contractual instruments including incentive pay, asset ownership, and job design. In the area of job design, an important aspect of their analysis concerns the degree of discretion granted to an agent. More precisely, the freedom the principal gives the agent to pursue different activities on the outside. Their central finding can be stated simply: "it is optimal to give the agent more freedom to pursue personal business when he is financially more responsible for his performance" (1991, p. 41). The result is intuitive and rests on the idea that agents have limited attention. When outside (private) activities are allowed and the agent does not have strong incentives to attend to inside (company) activities, he will redirect his attention away from the principal's business and toward his own.

The principal must balance the trade-off between the agent's lower effort and the lower wages required of an agent earning private compensation on company time. In Holmstrom and Milgrom's view, outside activities are simply a means for the agent to collect rents. Holmstrom and Milgrom (HM thereafter) emphasize that the weaker the incentives in place, that is the less responsive the agent's wage is to changes in firm profits, the greater will be the reduction in effort. This view implies that outside activities do not contribute to the provision of incentives in any way. If anything, they destroy work incentives because of agents' limited attention. Hence allowing outside activities becomes optimal only when the agent is financially responsible for inside activities.

By contrast, we provide a theoretical discussion of the conditions under which private activities appear to be desirable as an incentive mechanism. We argue that when the compensation the agent receives from the outside increases with his performance on the inside, allowing the outside activity will increase work incentives. When this happens, increasing effort not only increases production inside the firm (with the corresponding

incentive effects), but there is also an additional reward on the outside. There are several ways in which this link between inside and outside activities may arise. Most obvious is the case in which there is a technological link. Instead, we explore the possibility of incentive complementarities that do not rely on such direct effects. We discuss how such complementarities between inside and outside activities can arise from agents' individual reputations.

Our framework involves two periods and output being produced not only with effort (as in HM), but also with ability. This set-up follows in the spirit of Holmstrom's career concern model (Holmstrom, 1982) which emphasizes the role of uncertainty about ability in inducing effort even in the absence of explicit incentives. We assume that output is observable but non-verifiable —implying that contracts can only specify an uncontingent wage and whether outside activities are allowed. Despite not having explicit incentives, future wages will reflect expectations about ability. The agent will then exert effort in the first period to convince the principal and the outside market that she has high ability.

In this framework, we show that when ability is known ex-ante or outside activities do not depend on ability, the two tasks are substitutes and the results in HM obtain. In contrast, the same is not true when ability is uncertain ex-ante and is an input into both inside and outside production. In that case, the agent has an incentive to increase her effort in inside activities when she is allowed to benefit from outside activities. Not only will the agent receive the reward of a higher wage from the principal, but returns from the outside market increase when inside production increases, reflecting the higher expectations about ability. Allowing more freedom to the agent to exploit the returns from a reputation for high ability increases the incentives to acquire and retain that reputation in the first place.

Introducing ability in the model yields a rich new set of predictions. Besides the incentive effects of outside activities just described, there are additional effects not present in HM. The paper shows that, under certain conditions, it becomes optimal to grant more discretion, that is greater flexibility in allocating effort, to those agents who have performed

well in the past, and have acquired a reputation for high ability. High-performing agents would value outside activities the most. As a result, putting effort inside not only increases such an agent's compensation (inside and out), but also increases the chances of being granted more discretion in the future.

Furthermore, the presence of ability also brings scope for selection effects. When outside compensation increases steeply with reputation, those who perform well in the first period might see their outside opportunities rise more than their inside compensation. As a result they would decide to leave the principal when they are not allowed to profit from those opportunities. Allowing outside activities provides such agents a reason to continue on the job (even if it is at the expense of a decrease in effort).

Our model extends HM's analysis of the job design problem. They emphasize the role of an agent's limited attention in creating a conflict of interest when outside activities are allowed. Their multitasking model has been supported in recent empirical investigations (on the effect of outside activities on contract choice see Slade, 1996; on multitasking and incentives see Cockburn et al., 1999, and Brickley and Zimmerman, 2001; and Baker and Hubbard, 2002, on multitasking and the theory of the firm). However, we believe that, by explicitly considering the possibility of complementarities between inside and outside tasks, a wider range of employment settings can be explained. Furthermore, whereas HM argue that outside activities should only be allowed when the agent faces good incentives, we argue that in the presence of uncertainty about an agent's ability, an employer should offer the agent flexibility in allocating effort. Our central finding is that such discretion may have a positive impact on incentives.

Others have studied the problem of job design from different perspectives. Lindbeck and Snower (2000) focus on technological complementarities: intertask learning-by-doing, and intratask learning. Meyer et al. (1996) and Olsen and Torsvik (2000) study the interplay between implicit and explicit incentives, and its implications for job design. The latter focuses on the restrictions on outside activities, and argue that the presence of implicit

incentives can reverse the comparative statics in HM. They offer a model where implicit and explicit incentives move in opposite directions. As a result, when explicit incentives decrease, total incentives may still increase and make it optimal to allow more outside activities. Unlike the study at hand, Olsen and Torsvik do not consider the existence of synergies among tasks.

Recently, Dewatripont et al. (1999b) have studied a career concerns model with multitasking similar to ours. They explore incentives for government agencies and the effects of the scope of their missions (the number of activities under their responsibility). Consequently, they focus upon a model in which all activities are symmetric and only total effort matters. How that effort is allocated among each activity does not figure prominently in their analysis in contrast to ours. Moreover, future payoffs of the agent (and hence incentives) equal expected ability. As a result, the number of activities does not have a direct effect on compensation.¹ In our framework, we depart from both these assumptions, and consider asymmetric activities, with the rewards of the agent being dependent upon the restrictions on private activities. It is precisely the difference in how the agent gets compensated in the second period that explains the different predictions we obtain: while Dewatripont et al. (1999b) show that effort is decreasing in the number of activities, our results suggest effort might indeed increase when the agent's compensation reflects her increased responsibilities.

To illustrate the ideas of the model, we discuss in detail two examples. First we look at the familiar example of faculty employment in U.S. higher education. It is common practice to allow professors to complement their scholarship and institutional duties with a wide range of activities outside of the university: consulting to industry and government, public speaking, etc. Our model suggests that to the extent that a strong scholarly reputation opens the opportunity to benefit from these outside activities, faculty will not neglect their research output. We present some evidence consistent with our model from the 1998-99

¹There is an indirect effect, since the number of activities affects the process of learning about ability.

National Study of Postsecondary Faculty conducted by the U.S. Department of Education. We find that those faculty members that spend more time doing research earn higher returns on some outside activities (outside consulting, speaking fees, royalties and grants), but lower on others (such as legal/medical services, and self-owned business). We further see that the previous correlations are a good predictor for the size of the limited attention problem. While the correlation between effort in research and outside effort is negative for the second set of activities, it is positive (or non-negative) for the first. We then see a link between the effect of research on outside income, and the extent to which the activities are complements or substitutes.

Our second illustration, an important historical case, likewise does not accord with the HM result. The East India Company (1600-1858) pioneered English commercial exchange with Asia. It played a pivotal role in the development of the joint-stock, limited liability corporation and in the history of corporate finance.² The Company stationed its employees (called servants) in Asian cities to purchase pepper, textiles, tea, and other commodities for resale in London. Based on our own archival investigations at the India Office Library (London), we find that the Company offered employees, separated by more than seven months by sea, low wages and a flat wage structure. The inability to closely monitor the activities of the servants and enforce strong incentives would render, according to HM, any concession on outside activities inefficient. Yet we observe that the Company allowed and actively encouraged the servants to conduct their own trades. The discretion to pursue outside activities provided powerful incentives and was underpinned by asset complementarities between inside and outside trade. Agents exerted effort in Company trade in order to avoid dismissal, ensure access to firm resources, and increase the returns to private trade (as dismissals greatly reduced outside opportunities). This example shows how synergies of a different form, but analytically similar to reputational complementarities, sustained

²See for example Harris (2000) *Industrializing English Law*, Alborn (1999) *Conceiving Companies*, and Baskin and Miranti (1996) *History of Corporate Finance*.

the employment relation in one of the great fore-runners of the modern multinational.

The rest of the paper is organized as follows. Section 2 provides a formal articulation of the job design problem. We explore the optimality of allowing private trade and then study how our results vary under different assumptions. In section 3 we discuss the basic model in the context of faculty employment in U.S. higher education and other modern examples. Section 4 describes the employment relationship in the English East India Company and how we account for the observed contract design. And section 5 concludes. Proofs and tables are relegated to the appendix.

2 Job Design: A Formal Account

In this section we provide a formal examination of the job design problem. We model the conditions that would make allowing outside activities, such as private trade, desirable from a job design perspective. We start with the setup of the model, and a simple case that contains the main intuition of the paper. We then extend the model and relax the assumptions of the basic framework.

2.1 The Setup

A risk neutral principal hires a risk neutral agent for two periods, $t = 1, 2$, to conduct public trade.³ In period t , output will be produced with the following linear technology: $y_t = e_t + \eta + \varepsilon_t$. Output uses the agent's effort and ability, represented by e_t and η , respectively, as the basic inputs. But there is an additional random component, ε_t . Ability is unknown to both principal and agent, who share the same (symmetric) information. The prior distribution of ability is normally distributed with mean $\bar{\eta}$ and variance σ_η^2 , i.e. $\eta_t \sim N(\bar{\eta}, \sigma_\eta^2)$. The noise terms are assumed to be independent and normally distributed, $\varepsilon_t \sim N(0, \sigma_\varepsilon^2)$. We will denote the precision (the inverse of the variance) of each

³To avoid any confusion, we will refer to the principal as “he,” and to the agent as “she.”

random variable by h_η and h_ε respectively. The density of a random variable having a normal distribution with zero mean and variance of 1 will be represented by $\phi(\cdot)$, and its corresponding distribution by $\Phi(\cdot)$.

Output is assumed to be non-verifiable. Hence, the principal cannot optimally design an explicit incentive scheme to induce effort. However, as we will see shortly, the agent's wage will reflect her expected productivity. Effort will affect the principal's perception of the agent's ability and consequently the agent's period two compensation. Incentives will then be implicit and come from career concerns.

Besides the involvement in public (inside) activities, the principal might allow the agent to conduct private (outside) trade at $t = 2$. Such outside activity produces output $v(i_2, \eta)$ which accrues to the agent directly. i_2 represents the effort put into such activity. For simplicity, we will consider the case in which the outside activity only takes place at $t = 2$. We will discuss the implications of relaxing this in section 2.4. The function $v(\cdot)$ is assumed increasing in all arguments and concave in i_t , with $v_{ii} \leq -\kappa < 0$ for all (i, η) . To guarantee an interior solution we assume the derivatives with respect to i_2 satisfy $\partial v / \partial i_t \rightarrow +\infty$ as $i_t \rightarrow 0$. Since ability is uncertain, the actual return for the agent from the outside activity is $E[v(i_2, \eta) \mid \text{outsider's information}]$. We implicitly assume here that the agent obtains her rents from outside activities through another agency relationship. The outside principal infers ability from the information available to him and compensates the agent accordingly. For simplicity, we will consider only the case in which outsiders have the same information as principal and agent, namely, they hold the same prior beliefs about ability, and also observe first period performance, y_1 . Hence, no asymmetric information exists, which could give rise to adverse selection problems.

Since the agent is risk neutral, we can represent her expected utility as $U = E(W_1) - c(e_1) + E(W_2) - c(e_2, i_2)$, where W_t represents her total compensation received in period t . We follow Holmstrom and Milgrom (1991) in assuming that the agent faces a limited attention problem when given the option to allocate effort into the outside activity. We

model this by assuming a cost function of the form $c(e, i) = c(e + i)$, with $c(\cdot)$ being convex (increasing effort in one task increases the marginal cost of the other task).

We will denote the compensation the agent could obtain in an alternative employment relation by $\underline{u}(\eta)$. Notice we allow it to vary with the ability of the agent. Again, as it occurs with the outside activity, the agent would be able to exercise an outside option corresponding to the expectation of this function $E[\underline{u}(\eta) \mid \text{outsider's information}]$. We will further assume that $\underline{u}(\eta) < \eta$. This implies that any expectation of outside output is below the expected ability, and hence inside output. As a result, the agent will always prefer to work for the principal in both periods, even when the outside activity is not allowed.⁴

The principal sets a wage for each period, w_t . The offer is such that the expected surplus is divided according to their bargaining power: μ for the agent and $(1 - \mu)$ for the principal. It is assumed throughout the paper that $\mu > 0$. Furthermore, he can also design the restrictions imposed on the job, denoted by $\sigma \in \{0, 1\}$, which in this case corresponds to whether the agent is allowed to trade freely on her account at $t = 2$. Let $\sigma = 1$ indicate that the agent has been granted that privilege for period $t = 2$. Finally, to make things interesting, we will assume that the agent also faces incentives in the final period. We assume they take a linear form, so that she receives $w_2 + \beta y_2$, where w_2 is as above. $\beta > 0$ is the strength of the incentives, which will be taken as exogenous.⁵ The total compensation of the agent is then $W_1 = w_1$ in period 1, and $W_2 = w_2 + \beta y_2 + \sigma \cdot E[v \mid \text{outsider's information}]$ in period 2. We will restrict attention to sequentially optimal short-term contracts.

To sum up, we outline the timing of the model. Before each period, principal and agent bargain over the terms of the contract. The principal finally makes an offer w_t . Upon acceptance of the contract, the agent is hired. She then works during the first period, according to the terms of the contract. Output is then realized. The principal and outside

⁴The implications of relaxing this assumption are discussed in section 2.4.

⁵We can think of β as the incentives coming from future career concerns (period 3 and after), which cannot be altered by the principal. In such a case, the agent would also take this into consideration in the first period, as y_1 also affects the perception of ability. This would not affect our results. However, the formulation in the text (where β only affects y_2) is simpler.

market form an expectation of the effort level of the agent (which we will denote by $\widehat{e}$), and together with the realization of output they infer a level of ability. In equilibrium, such conjecture will equal the true level of effort chosen by the agent (which in turn will depend on the effort level expected). In the second period, the agent may be rehired again after bargaining over the new terms of the contract. In that case, she gets compensated, then chooses the effort levels, and finally, the second period output is realized.

2.2 Benchmark Case: the Second Period

Before getting into the main results of the paper, it would be useful to look at the behavior in the second period. Since this is the last period, there is no room for reputations and hence implicit incentives.

Some notation will prove useful for the rest of the paper. The unconditional expectation $E[\cdot]$ will denote first period expectations with respect to ϵ_1 and the prior distribution of η . $E[\cdot | y_1, \widehat{e}]$ will instead represent the (conditional) expectation with respect to ϵ_2 and the posterior distribution of η (given y_1 and $\widehat{e}$).

The agent then maximizes her expected utility:

$$\max \left\{ w_2 + \beta \cdot (e_2 + E[\eta | y_1, \widehat{e}]) + \sigma \cdot E[v(i_2, \eta) | y_1, \widehat{e}] - c(e_2 + i_2) \right\}$$

The first order conditions that arise from this problem are:

$$\begin{aligned} \beta &\leq c'(e_2 + i_2) \\ \sigma \cdot E[v(i_2, \eta) | y_1, \widehat{e}] &\leq c'(e_2 + i_2) \end{aligned} \tag{1}$$

with $e_2^* = 0$ if the first condition is satisfied with strict inequality, and $i_2^* = 0$ if the second is.

Notice that the conditions in (1) are identical to those derived by Holmstrom and Milgrom (1991). Because introducing ability in the static model does not affect the results

in a dramatic way, the conditions in (1) are not surprising. The same principle of optimal job design they derive would apply here. In particular, the outside activity would only be allowed if the agent faces good incentives (high β). However, this set up enables us to study (in section 2.3) how the optimal discretion policy changes with the ability of the agent.

In contrast to their model, we assume the agent has positive bargaining power. In this case, the fixed wage, w_2 , will be such that the agent is guaranteed her share of the surplus:

$$w_2 + \beta \cdot (e_2^* + E[\eta \mid y_1, \hat{e}]) + \sigma \cdot E[v(i_2^*, \eta) \mid y_1, \hat{e}] - c(e_2^* + i_2^*) = (1 - \mu) \cdot E[\underline{u}(\eta) \mid y_1, \hat{e}] + \mu \cdot \Pi_2$$

where Π_2 denotes the total welfare generated in the relationship, and is equal to $\Pi_2 = e_2^* + E[\eta \mid y_1, \hat{e}] + \sigma \cdot E[v(i_2^*, \eta) \mid y_1, \hat{e}] - c(e_2^* + i_2^*)$.

We will also explore the conditions under which outside activities produce an incentive effect rather than a conflict of interest. Outside activities raise incentives when effort inside increases the compensation outside and hence the returns to effort increase after discretion is allowed. In terms of the previous first order conditions with respect to e :

$$\beta + \sigma \cdot \frac{\partial v}{\partial e} = c'(e + i)$$

incentives will increase with $\sigma = 1$ whenever $\partial v / \partial e > 0$. We will see next the conditions under which this takes place.

2.3 The Incentive Effect of Discretion

Let us now look at the two-period version of the model. We will solve the model by backward induction. The final period corresponds to the one period solution described above. However, expectations would have to reflect the increased information about ability. We will denote the expected welfare generated by $\Pi_2 = e_2^* + E[\eta \mid y_1, \hat{e}] + \sigma \cdot E[v(i_2^*, \eta) \mid y_1, \hat{e}] - c(e_2^* + i_2^*)$.

Then, for a given first period offer, w_1 , the agent solves the following problem:

$$\max_{e,i} E \left\{ w_1 - c(e_1) + (1 - \mu) \cdot E[\underline{u}(\eta) \mid y_1, \hat{e}] + \mu \cdot \Pi_2 \right\} \quad (2)$$

where $E[\cdot]$ denotes the first period expectation as defined above.⁶

In the first period, the agent decides the level of effort. Output is then realized and the second period begins. At that stage, she bargains with the principal over the division of the surplus, and is able to extract a fraction μ above her outside option. She then receives the second period wage (contingent on first period output), and, if applicable, the returns from the investment in the outside activity.⁷ Effort affects expected second period returns through a higher probability of realizing a high output, and hence inducing high expectations of ability. This yields the following first order condition with respect to e_1 :

$$E \left[(1 - \mu) \cdot \frac{\partial E[\underline{u}(\eta) \mid y_1, \hat{e}]}{\partial y_1} \cdot \frac{\partial y_1}{\partial e_1} + \mu \cdot \frac{\partial \Pi_2}{\partial y_1} \cdot \frac{\partial y_1}{\partial e_1} \right] = c'(e_1)$$

This condition simply states that marginal return should equal marginal cost in an interior solution. A higher effort level will increase the odds of realizing a high output. As a result, the chances of acquiring a reputation for high ability are improved, with the corresponding effects on the rents obtained in the second period.

We begin by studying the cases where ability does not play a big role. Suppose η is known ex-ante. In this case, the first period realization of output provides no additional information about second period ability. Then, both $E[\underline{u}(\eta) \mid y_1, \hat{e}]$ and Π_2 are independent of y_1 . The first order condition is then $0 = c'(e_1)$, independently of whether discretion is allowed or not. Hence, σ does not affect the agent's problem in the first period.

Similarly, when returns from the outside activity are independent of ability (i.e., $v_\eta(i, \eta) =$

⁶Notice that from an ex-ante perspective, the second period wage is uncertain, since it depends on the realization of ϵ_1 and η .

⁷We have assumed that principal and outside market share the same conjecture about the effort level, $\hat{e}$. This is without loss of generality, since that will certainly be the case in equilibrium.

0) we can write $v(i)$. Then, $E[v(i, \eta) | y_1, \hat{e}] = v(i)$ is independent of y_1 . The marginal return to effort becomes $(1 - \mu) \cdot \frac{\partial E[\underline{u}(\eta) | y_1, \hat{e}]}{\partial y_1} \cdot \frac{\partial y_1}{\partial e_1} + \mu \cdot \frac{\partial E[\eta | y_1, \hat{e}]}{\partial y_1} \cdot \frac{\partial y_1}{\partial e_1}$ regardless of whether outside activities are allowed or not. Again, this results in the outside activity reducing effort inside in the second period, without an additional beneficial incentive effect in the first. We summarize this in the following proposition, which states the conditions under which HM's assertion that outside activities crowd out effort inside hold:

Proposition 1 *Allowing the outside activity substitutes effort away from the inside activity at $t = 2$ without affecting incentives at $t = 1$ (i.e., $e_2^*(\sigma)$ is decreasing in σ , while $e_1^*(\sigma)$ is constant) in the following cases:*

- i. ability is known*
- ii. outside activity is independent of ability, i.e. $v_\eta(i, \eta) = 0$.*

This proposition parallels HM's multitasking analysis of outside activities. Namely, since the agent has limited attention, increasing the number of tasks she performs outside decreases effort in the tasks that benefit the principal. In each period, the first order conditions reduce to the same ones HM find for their static problem (with the only difference that incentives come from career concerns considerations rather than being explicit). Consequently, analogous results would apply to this framework: as (implicit) incentives get stronger, outside activities become more desirable.

2.3.1 Discretion and Ability

We now turn to the case where ability plays a more central role. We will assume η is uncertain ex-ante. Both principal and agent will learn about ability from the first period output. So will outsiders, since they can also observe output. The learning process that arises from our assumptions is well known. If we let the conjecture the principal has about effort be $\hat{e}$, the prior about ability will be updated with the signal $y_1 - \hat{e} = \eta + \varepsilon_1$, which

is normally distributed with mean η and variance σ_ε^2 . The posterior will also be normal, with mean $m = E[\eta \mid y_1, \hat{e}]$ given by:

$$m = \alpha \bar{\eta} + (1 - \alpha) (y_1 - \hat{e}), \text{ where } \alpha = \frac{h_\eta}{h_\eta + h_\varepsilon}$$

The precision of the posterior distribution equals the sum of the precision of the prior and the signal, $h_\eta + h_\varepsilon$.

The agent still solves the same first period problem:

$$\max_{e,i} E \left\{ w_1 - c(e_1) + (1 - \mu) \cdot E[\underline{u}(\eta) \mid y_1, \hat{e}] + \mu \cdot \Pi_2 \right\} \quad (3)$$

Denote the solution to this problem by $e_1^*(\sigma, \hat{e}_1)$.

Expectations in the second period now reflect the learning about ability. Moreover, compensation from the outside activity is

$$E[v(i, \eta) \mid y_1, \hat{e}] = \int_{-\infty}^{+\infty} v(i, \eta) \cdot \sqrt{h_\eta + h_\varepsilon} \cdot \phi((h_\eta + h_\varepsilon)(\eta - m)) \cdot d\eta$$

Introducing uncertain but persistent ability creates incentives for the agent to work hard to persuade the market she is skillful, since that results in higher future wages. The stronger the career concerns, the stronger the incentives. Furthermore, in this case outside activities can become complementary to and increase effort in inside activities. To see this, it is useful to consider the case in which σ takes either a value of 1 or 0, independent of the realization of first period output. This would be the case if, for instance, the principal had to impose the restrictions on discretion in the first period (before the realization of y_1). As a result, when the agent is allowed more discretion in the second period, she might face a larger reward for sending a good signal about ability. Hence, incentives in the first period might consequently increase. The next proposition makes this comparison explicit:

Proposition 2 *Suppose that σ is set before the realization of y_1 . Then, for a given belief*

about effort, $\hat{e}$, the optimal effort level e_1^* is increasing in σ when $v_\eta(i, \eta) > 0$ and either of the following conditions is satisfied:

i. $v_{i\eta}(i, \eta) = 0$, or

ii. $v_{i\eta}(i, \eta) > 0$ and $v_\eta(0, \eta) > \frac{(1-\beta)}{\kappa} \cdot v_{i\eta}(i, \eta)$ for all (i, η)

Furthermore, $i_2^*(y_1)$ is increasing in y_1 , and $E_{\varepsilon_1}[i_2^*(y_1) | e_1]$ is increasing in e_1 under condition (ii).

Proof. See Appendix. ■

This proposition expresses the main result of the paper: when there is uncertainty about ability, outside activities can come to complement incentives for effort in inside activities. As long as the rents the agent obtains from outside activities depend on her ability, allowing them provides a stronger incentive to acquire a reputation for high ability, since the agent's second period payoff varies with y_1 to a greater extent. Not only does she receive the benefit of a higher wage from the principal, but outsiders will also recognize her value and compensate her accordingly. Outside activities provide the agent with an opportunity to exploit her reputation further. Hence, increasing ex-ante incentives to acquire such reputation. Moreover, when e increases, the likelihood she will gain a good reputation is improved. This in turn increases the likelihood that the agent will devote a large effort into the outside activity in the future.

The only complication arises for the case in which outside effort and ability are complements. There, discretion discourages future effort inside (at $t = 2$), which could make period 2 welfare decrease with y_1 . The second part of condition (ii) guarantees this does not happen. Intuitively, it requires that the increase in outside output due to ability is large enough to compensate for the loss of inside output coming from the limited attention problem (which becomes worse with ability when $v_{i\eta} > 0$). Notice that when $\beta = 1$, the expression collapses to $v_\eta(0, \eta) > 0$, which imposes no further restrictions. This is

so because when the agent faces perfect incentives, setting $\sigma = 1$ produces the first best outcome, which is increasing in ability.

We now turn to analyze the equilibrium. Given the optimal response of the agent to a certain belief of the principal, $e^*(\sigma, \hat{e})$, an equilibrium effort level is characterized by the equation $e = e^*(\sigma, e)$. We will denote by $E^*(\sigma)$ the set of equilibria as a function of the restrictions on outside activities. The equilibrium effort levels have the following property:

Proposition 3 *When the outside activity is not allowed, there is a unique equilibrium effort level, $e^*(0)$. Suppose that $v_\eta(i, \eta) > 0$, and either of the conditions in Proposition 2 are satisfied. Then, when the outside activity is allowed the effort level at any equilibrium increases: for any $e^* \in E^*(1)$, $e^* > e^*(0)$.*

Proof. See Appendix. ■

When outside activities are not allowed, the effort level chosen by the agent is independent of the conjectures about effort. As a result, this will be the unique equilibrium. However, when outside activities are allowed, it is not possible to guarantee a unique equilibrium. When investment and ability are complements, a multiplicity of equilibria might arise. It remains the case, however, that any equilibria will have a higher effort level when the outside activity is allowed than when it is forbidden. Moreover, these increased incentives come at no cost for the principal.

Finally, we turn to the analysis of the optimal discretion policy. We have shown that allowing the outside activity increases incentives when the reputation of the agent affects her compensation. As in HM's analysis, the principal will weight the benefits and costs of allowing outside activities. The cost comes from the limited attention of the agent. In other words, the decrease in inside effort. The benefits, on the other hand, stem from the additional rents that are generated in the relationship. When ability is involved, the net benefits may vary with the first period output (and hence the perception of ability). The following proposition makes this explicit.

Proposition 4 *Suppose that σ is set after the realization of y_1 . Then, the optimal discretion policy $\sigma^*(y_1)$ is increasing in y_1 when $v_\eta(i, \eta) > 0$ and either of the following conditions holds:*

- i. $v_{i\eta}(i, \eta) = 0$, or*
- ii. $v_{i\eta}(i, \eta) > 0$ and $v_\eta(0, \eta) > \frac{(1-\beta)}{\kappa} \cdot v_{i\eta}(i, \eta)$ for all (i, η)*

Proof. *See Appendix. ■*

The outside activity will only be allowed when the benefits of doing so outweigh the costs. The benefits consist of the value of those activities for the agent.⁸ The costs, on the other hand, account for the loss of output to the principal due to limited attention. Those agents with superior ability will find the value of the outside activity to be higher. Hence, the benefits of choosing $\sigma = 1$ are increasing in ability. At the same time, when ability and outside effort are independent of each other (condition i.), more able agents will become equally distracted. The cost would then be constant. It follows that the net effect is clearly increasing in ability. When outside effort and ability are complements, the costs are also increasing in ability: more able agents will get more distracted. The second part of condition ii. ensures that the benefits still outweigh the costs when ability is higher. Intuitively, the returns to ability outside (which increase rents) should be large, compared with the complementarities (which cause the higher distraction).

Under the two cases in proposition 4 that make the discretion policy increasing in y_1 , there is yet another reason for the agent to increase effort inside during the first period. The discretion policy encourages the agent to obtain a reputation for high ability, benefiting her compensation both inside and outside. In so doing, she will also convince the principal to grant more discretion in the future.

⁸Notice that the additional benefit coming from improved incentives in the first period is not taken into account, as the discretion policy is chosen in the second period.

2.4 Discussion of Additional Issues

In this section we discuss the implications of relaxing some of the assumptions we made in the basic framework with regards to the structure of outside activities.

2.4.1 Discretion and Selection

When we allow for the possibility of output (both inside and outside) depending on unknown ability, a new set of effects arise. We showed above that an incentive complementarity might arise between the two activities. Previously, we have conveniently assumed for simplicity that $\underline{u}(\eta) < \eta$. As a result, the alternative compensation on the outside is always lower than inside. The agent would never choose to quit the inside activity and undertake the outside activity alone. However, when we drop this assumption there are selection effects that would have to be taken into account.

Whenever the outside activity of the agent goes above the total surplus generated by working for the principal, it becomes optimal to break the relationship. The agent would exercise her outside option, and the principal would make zero profits. However, when the output on the outside activities depends on the ability of the agent, such selection effects will depend on the discretion policy.

When ability plays a role in output production, it is reasonable to assume that the outside option of the agent will depend on her reputation. The agent will always accept the job in the first period. But now the outside opportunities of the agent will depend on the reputation gained during the first period. And this might result in the agent quitting right before the second period. Suppose, for instance, that $\underline{u}'(\eta) > 1$. In this case, ability is highly rewarded in the outside. Since $\underline{u}(\eta)$ increases faster than y_t with ability, the ex-post expectation of $\underline{u}(\eta)$ will eventually surpass that of y_2 as y_1 increases (or equivalently, as ex-post expected ability increases). As a consequence, those who perform well in the first period will find their outside value to be higher than their inside compensation. They would decide to quit when outside activities are prohibited. Only poor performers will

remain, resulting in adverse selection.

Allowing the outside activity could have an additional beneficial effect: it can prevent adversely selecting those agents who are revealed to have low ability. If $\underline{u}'(\eta) < 1 + v_\eta(0, \eta)$, then the output of an agent that is granted discretion (including the proceeds from the outside activity) will surpass the outside option when ability is sufficiently high. By setting $\sigma = 1$, the principal would then ensure that the most able agents find it attractive to stay. These observations are summarized in the following proposition.

Proposition 5 *The following results hold:*

- a. If $\underline{u}'(\eta) > 1$, then $\exists \hat{y}$ such that for any first period output realization $y_1 \geq \hat{y}$ the agent quits after the first period and exercises his outside option if $\sigma = 0$.
- b. If $\underline{u}'(\eta) < 1 + v_\eta(0, \eta)$, then $\exists \tilde{y}$ such that for any first period output realization $y_1 \geq \tilde{y}$ the agent does not quit after the first period if $\sigma = 1$.

Proof. See Appendix. ■

From the previous proposition, it immediately follows the next result about the optimality of discretion:

Corollary 6 *Suppose that $1 < \underline{u}'(\eta) < 1 + v_\eta(0, \eta)$. Then, $\sigma^*(y_1) = 1$ for any $y_1 \geq \hat{y}$ (where $\hat{y}$ is as defined in proposition 5).*

When the outside option of the agent lies between the output from the inside activity and the output including the outside activity, the principal will find it optimal to set $\sigma = 1$. By doing so, it deters the agent from quitting, and hence is able to capture a fraction of the surplus generated. Whenever outside opportunities are increasingly more attractive for highly reputable agents, we will further see a tendency towards a discretion policy that favors such agents. In other words, this consideration would further favor a policy $\sigma(y_1)$ which is increasing in y_1 , reinforcing the effects in the previous section.

Moreover when the agent is allowed to pursue outside activities, her ex-ante expected compensation increases. The job is then more attractive and increases the likelihood that the agent accepts ex-ante. On the other hand, when the principal decides to prohibit outside activities, the agent might decide not to join at all, preferring instead to work on the outside from the beginning. Allowing outside activity mitigates adverse selection, a feature not recognized in previous research. Discretion makes the job more desirable. It increases the principal's ability to attract the agent ex-ante and retain her ex-post.

2.4.2 Reputational Costs: Learning from Outside Activities

In the previous section we developed the basic argument using a model in which outside activities were taking place in the second period, and incentives at that time were linear in inside output. This effectively ruled out the possibility of learning about ability from the output on the outside activity. We discuss this possibility here. Besides the incentive effects described above, a reputational cost arises.

For simplicity, consider the case in which incentives come from reputations as well. That would be the case if the agent was paid her expected ability in a third period. To keep things as simple as possible, we assume that output from both activities is non-verifiable, but observable to the principal, agent, and outside market. As before, output in the inside activity takes the linear form $y_t = e_t + \eta + \varepsilon_t$. Similarly, we also assume separability between outside effort and ability for simplicity. Outside activities will produce $v = g(i_2) + \gamma(\eta + \xi_2)$, where $\xi_2 \sim N(0, \sigma_\xi^2)$, $g(\cdot)$ is concave and $\gamma \geq 0$. By assuming that the parameter γ multiplies both η and ξ_2 , we make the signal to noise ratio independent of γ . This will turn out to be useful for separating the effects of a higher productivity of ability and a more informative signal when doing comparative statics. The random variables η , ε_t , and ξ_2 are all independent of each other.

We start first by looking at the case where outside activities are not allowed. The learning process, and hence the problem of the agent, are just as before. The choice of

effort will come from the first order condition:

$$1 - \alpha_2 = c'(e_2), \text{ where } \alpha_2 = \frac{h_m}{h_m + h_\varepsilon}$$

where h_m denotes the precision of the posterior distribution of ability after the first period: $h_m = h_\eta + h_\varepsilon$. To compare the equilibrium with the case with outside activities, we will denote these variables by $\alpha_2(\sigma = 0)$ and $e^*(\sigma = 0)$.

When both activities are allowed there is more information available to update beliefs about ability. This new information can be combined to provide a signal with which to update beliefs:

$$z_1 = E[\eta \mid y_1, v_1] = \frac{h_\varepsilon(y_2 - e_2) + h_\xi\left(\frac{v - \hat{i}_2}{\gamma}\right)}{h_\varepsilon + h_\xi}$$

the precision of the signal being $h_\varepsilon + h_\xi$, and the conjecture about outside effort $\hat{i}_2$. The updating process becomes:

$$m_2 = \alpha_2 m + (1 - \alpha_2) z_1 = \frac{h_m m + h_\varepsilon(y_2 - \hat{e}_2) + h_\xi\left(\frac{v - \hat{i}_2}{\gamma}\right)}{h_m + h_\varepsilon + h_\xi}, \text{ where } \alpha_2(1) = \frac{h_m}{h_m + h_\varepsilon + h_\xi}$$

Therefore, having the two activities is equivalent to observing a single output, z_1 , whose precision is the sum of the two. The same analysis we had above carries through for z_1 .

Notice that $\alpha_2(1) < \alpha_2(0)$. When the agent engages in the outside activity, more information about her ability becomes available. This additional information makes the initial information (from the inside activity) less valuable for updating beliefs and thereby reducing the weight they play in the formation of posterior beliefs. As a result, the incentives coming from the inside activity get reduced and less effort would be put inside (even in the absence of limited attention problems).

It is worthwhile mentioning, however, that this cost of discretion is a function of the relative informativeness of the outside activity h_ξ . The incentive effect described in the previous section is a function of the derivative of outside output with respect to effort,

namely γ . In the current formulation, both these parameters are independent of each other. As a result, the previous analysis would still be unchanged keeping constant the value of h_ξ .

3 Job design: contemporary examples

In this section we describe several modern examples, with a special attention to incentives in academe. They suggest that an analysis based solely on conflicts of interest might not give us a full understanding of job design problems.

3.1 U.S. Higher Education

Our model gives some new insights on the role of outside activities in the provision of incentives to faculty in U.S. higher education. It is a common practice to allow college and university professors to engage in remunerative outside activities such as outside teaching, sponsored research, consulting, public speaking, and other projects related to her field of expertise. That colleges and universities are actively interested in the allocation of effort between inside and outside activities is evident in policies governing faculty consulting, privately sponsored research, conflicts of interests, and the like. Some universities require department chairs to be notified of and to approve all faculty participation in outside activities. Others insist that a share of external grants received go to the university. Such policies testify that it is of course possible that some non-university activities may place competing demands on a faculty member's attention, as HM suggest.

Our theory suggests that to the extent that success in employer-centered tasks, for example a solid record of scholarly achievement, signals high ability to outside employers, it may have a corresponding positive impact on private, non-university, options. Therefore, the availability of such outside options may encourage greater effort in research (or, at least, mitigate any potential conflict of interest). As a result, the degree to which limited attention is a problem depends on how research affects income from the outside. Furthermore, this

greater freedom can help to retain more talented faculty if they are able to obtain large rewards in an alternative employment.⁹

To further examine these predictions, we analyze the 1999 National Study of Postsecondary Faculty conducted by the U.S. Department of Education.¹⁰ The data provide detailed employment information on approximately 18,000 individual U.S. faculty members. The study collects information on numerous dimensions of faculty employment including income from outside activities and allocation of time across different tasks.

In Table 1 we focus on the link between inside and outside activities arising from the data. The first column reports the correlation coefficient between supplementary income in each of the eight categories of outside activities and research effort. Research effort is negatively correlated with income received from other academic institutions, other employment, legal or medical services (including psychological counseling), and self-owned business. At the same time, research effort is positively correlated with income from consulting, speaking fees, royalties and grants. The correlations suggest that a scholarly reputation is more important for certain outside activities than for others. The second column confirms the statistical significance of these correlations with an OLS regression of outside income on research effort.

Column three then shows the average research effort (as the percentage of time spent on this activity) for those who report a positive income from each outside activity. The numbers suggest there is a lower level of effort among those who engage in the first four activities (for which research had a negative impact on income). Column four compares the statistical significance of these averages by regressing effort in research on a set of dummies for each outside activity (taking a value of 1 if the income from that activity is positive).

⁹ *The Economist* (March 16, 2002, p.40) has emphasized this later point when discussing the conflicts of interest of faculty in American Universities. In their view, allowing star professors to do freelance work is good for the university, as they may otherwise leave the institution since they typically have very good outside options.

¹⁰ In an earlier version of the paper we analyzed the publicly available faculty subsample of the 1969 Carnegie Survey of Higher Education. The results from the Carnegie Survey are analogous to the ones presented here.

This suggests a relation between the importance of research for outside income, and the level of attention devoted to research when also working outside, as the theory emphasizes.

Tables 2 and 3 make the same comparisons for partial correlations, after introducing some additional controls. In table 2 we look at the relation between research effort and outside income, controlling for outside effort, salary at the institution and experience, and including rank, field of teaching and institution fixed effects. Although the estimated effect is small, most of the correlations survive after introducing the controls.¹¹ It is only reversed for income coming from another academic institution.

To understand the extent of the conflict of interests, we regress research effort on time spent on outside activities. Unfortunately, the later is not reported for each individual activity. We only have the total amount of time spent on all outside activities. The coefficient on this aggregate measure reported in table 3 is negative, consistent with there being a conflict of interest between the different tasks. In order to identify the effect for the different outside activities, we also interact time spent on outside activities with a set of dummies that take a value of 1 if the income from the corresponding outside activity is positive. These interactions give us the differential effect of outside effort, depending on the activity with which the faculty member is involved. Effectively, they attribute the aggregate measure of outside effort to the particular activity the faculty member is engaged in. For instance, if a faculty member only does outside consulting, and we attribute all the reported outside effort to that activity, then the size of the limited attention problem will be measured by the sum of the coefficient on outside effort and its interaction with the dummy for outside consulting. In Table 3 we can see that the direction of the effects mirrors that obtained in Table 2. For other employment, legal and medical services, and self-owned business, outside effort reduces time on research by more than the other activities

¹¹The size of the coefficients may be due in part to the large number of faculty members that do not report any income from outside activities. As is well known, this selection problem causes the coefficients to be biased towards zero. The problem may be exacerbated if respondents underreport their income from outside sources.

do (for some of these activities, the limited attention problem is indeed negligible). This is suggestive of a link between the effect of research on outside income and the size of the conflict of interest.

This evidence can shed light on the debate over faculty conflict-of-interest, which has come into sharper focus with the growth of corporate support for university research.¹² Opponents of this trend have pointed out that external sponsorship of faculty research detracts from faculty members' other core responsibilities, such as teaching and service. Opponents further argue that outside opportunities reward applied research at the expense of basic research and may even compromise the objectivity of faculty investigators. Proponents of private sector collaboration emphasize the need to bring diverse specialists together and to broaden sources of research funding. At a recent symposium on the life sciences hosted by the Harvard Business School, Harvard President Lawrence Summers also stressed these complementarities by saying that "[...] we must be prepared to work cooperatively with the private sector. We must recognize that [...] conflict of interest is one side of the coin, and synergy is the other side of the coin."¹³

3.2 Other examples

Other professions also place a similar emphasis than academe on the trade-off between conflicts of interests and reputational synergies when dealing with outside activities. That is the case in journalism or among librarians, for instance. Oftentimes journalists combine a multitude of activities at several media outlets. Recently, as a response to Lord Hutton's inquiry on the death of Dr. Kelly, the British Broadcasting Corporation (BBC) has decided

¹²For a searing, one-sided critique of the trend see *Steal this University*, edited by Johnson, Kavanagh, and Mattson. While state entities vigorously advocate university-industry collaborations as a strategic means to enhance a region's economic growth, implementing policies that reward such collaborations remains a challenge. See for example the article "Professors Question 'Bonuses' Based on Grants" appearing on 2 May 2003 in the *Chronicle of Higher Education*.

¹³The full speech is available at <http://www.president.harvard.edu/speeches/2003/lifesci.html>.

to ban its reporters from writing columns for newspapers.¹⁴ As a result of that, several top professionals (including Rod Liddle, from the *Today* programme, and Rosie Millard, a high-profile arts correspondent) have announced they would leave the BBC. The discretion they had to pursue these outside activities must have certainly encouraged them to stay at the BBC before the change, as our model suggests.

The US Association of Colleges and Research Libraries writes, with respect to rare book, manuscript, and special collections librarians: “Certain types of outside employment, including teaching, lecturing, writing, and consulting, can be of benefit to both the institution and the employee by stimulating professional development. Consequently, special collections librarians should be encouraged in these activities.”¹⁵

Many professional athletes, also, have started restaurant chains, starred in motion pictures, written autobiographies and pursued numerous activities while being active players. Even though they certainly face very strong incentives to continue improving performance, being a star athlete has obvious positive externalities for their private business. It seems natural, then, to see these outside activities as an important factor driving their motivation, much in the spirit of our model.

4 Job design: an historical account

Our model provides insights to job design problems encountered in many settings including those from corporate history. Consider the case of the English East India Company, 1600-1858. One of the great fore-runners of the modern multinational firm, the East India Company should have been an exemplar of the principle that financial responsibility and authority should go hand in hand (Holmstrom and Milgrom 1991, p. 41). As in

¹⁴The Hutton inquiry was set up to investigate the death of Dr. David Kelly, a UK-government scientist linked to claims from a BBC reporter that Downing Street had ‘sexed up’ intelligence to make a stronger case for the war in Iraq, claiming Saddam Hussein had weapons that could be deployed in 45 minutes. In his report, Lord Hutton exonerated the UK government from any wrong-doing, putting the blame on the BBC for failing to check the accuracy of the claims made by their reporter.

¹⁵The full document is available at <http://www.ala.org/ala/acrl/acrlstandards/standardsethical.htm>

the case of faculty employment, we find instead low explicit incentives to exert effort in inside activities plus the provision to trade privately. We focus mainly on the first half of the eighteenth century and base our discussion on our own archival investigations into the firm. The discussion first summarizes the employment relationship within the Company and then assesses how an extension of the model can characterize that relationship.

4.1 Overview of the employment relationship

Between 1700 and 1757, the Company directors (located in London) sent 303 employees to Bengal (India) to acquire commodities for resale in London. Upon arrival, Company employees, called servants, employed the firm's cash, physical assets, and intangible assets in a range of transactions all aimed at generating sales revenues. Examples of such transactions included contracting with indigenous merchants for future delivery of cotton piecegoods, minting and disbursing the Company's treasure, repairing and maintaining the Company's buildings and grounds, repairing and outfitting the Company's ships, and negotiating trade privileges with the Mughal authorities.¹⁶ The challenge for Directors was to motivate servants to undertake these transactions at minimum cost.

The employment relation between Directors and servants was challenged by the time and distance between the two and by high risk of mortality facing Europeans in India in the period. At least 7 months sea travel separated principal from agent in each direction. The consequent bottlenecks in information flows necessitated flexibility and incompleteness in the contract. In a letter to the Bengal President and Council, dated 11 February 1731/32, the Directors write, "If hereafter any unforeseen accident happens of the like kind, to render a strict compliance of our orders impracticable, we shall never be displeased, if upon mature considerations you take such measures as will make the disappointment most easy to us, in respect to our profits here, which you must be tolerable good judges of"

¹⁶For a more detailed account of the employment relationship in the EIC and a full description of the archival data see Hejeebu (2004). Chaudhuri (1978) describes the organization of the Company and its trading system. Marshall (1976) documents the private trade of servants in India.

(O.I.O.C. Despatch Books vol. 105, p.447, para. 77). The “disappointment” or the cost of undertaking transactions was approximated 7 months after the fact by men who had no direct experience in the Indian market and little concept of accrual accounting. Such time and information gaps made it unlikely that incentives based on level of reported cost reductions would be feasible.

The second contractual hurdle arose because of the high degree of mortality of Europeans in Asia. Using life table analysis, Hejeebu (1998) reports that for the cohort of employees entering the service between 1700-1724 the chance of dying within the first five years was 31%. The median length of service was just 9 years. The high mortality rates most likely biased the interests of the servants towards pursuing their own short-term objectives, rather than the long-term interest of the Company. The mortality threat made it unlikely that fixed wage incentives would motivate those with most seniority and authority.

To overcome these exogenous constraints, the incentive scheme in the English East India Company specified in the actual contracts involved a fixed annual salary, room and board, promotion based on strict seniority, and the privilege of trading within Asia. Overseas employees were grouped into four ranks based strictly on seniority. The higher ranks were associated with greater responsibility and higher salaries. Company salaries, however, were paltry by the standards of the period. Langford (1989, 63) suggests that middle class membership would require an annual family income of at least £ 40 per annum, obtainable in the Company’s service only after 11 years. The odds were against an agent surviving that long.

The Company instead provided high-powered incentives through the provision of private trade. Instead of demanding “financial responsibility” as HM would have it, the Directors permitted servants to participate in any trade within Asia while on Company time. The value of participating in lucrative Asian trades meant that the value of outside activities greatly exceeded inside remuneration. By individually tracking the 1493 remittances by Company employees in Bengal between 1747 and 1756, Hejeebu (2004) shows that the value

of private trade rose with each year in service. In the first five years of service, remittances amounted to £139 per employee per year. In the next five years, remittances climbed to £406; in years 11-15, £1,416; and in years 16-20, £2,297. The Directors' most effective punishment against servants' violating contractual norms was dismissal. Among the 303 persons who entered the Bengal service from 1700 to 1756, 40 (13.2%) were dismissed, suspended, or transferred. We find that the great bulk of dismissals occurred at the top, upon the senior managers. Senior servants had a 23% chance of being dismissed and recalled to London.¹⁷ Senior servants had the most to gain by private trade and the most to lose by dismissal.

The case of Richard Becher (1744-1758) is illustrative. Becher arrived in Bengal in 1744 at the rank of factor. Over the course of his 15 year career, he purchased a total of 19 bills valuing £8,781 against the Company in London. However he made no remittances in the first 8 years. In his 11th year, 1754, he sent 3 bills totalling £ 607, in the next year 6 bills worth £926. In his last year, Becher, now a member of the Calcutta Council and serving as the Company's accountant, sent 4 bills worth £6,648. The close details of Becher's pattern of remittances, and many others like it, reveal that for servants in the field the value of the employment relation increased with seniority. This in turn made the threat of dismissal an effective way to discipline powerful veterans.

In an environment with poor monitoring, contract incompleteness, and high mortality, why did the servants not redirect their effort away from the Company's goals altogether? As in the case of faculty employment, synergies between public objectives and personal ones enabled the relationship to thrive.

The most important synergy between the Company's public and servants' private trades emerged from their common use of government trading privileges, which the Company called "purchased privileges." These intangible assets ensured the legal basis of the Com-

¹⁷ A dismissed servant rarely remained in India. A dismissed servant was typically given one year to settle his accounts and was ordered back on the next year's shipping. Other members of the Company were instructed to force him home.

pany's trade in India. While the Company held royal and later Parliamentary charters giving it exclusive English access to Asian waters, in India, the Company needed local recognition of the right to trade. They sought and obtained several such decrees, the most important of which came from the Mughal court in 1717. The broadly worded *firman* or imperial grant gave the Company the right to trade in Bengal free of customs and in-land transit tax in exchange for a small annual payment of Rs. 3,000. Even though the agreements were not originally intended to apply to the private trade of Company employees, the servants insisted that the Company's privileges applied to all Englishmen in Bengal whether in their public activities or in their private activities. From 1717 onwards, Company employees no longer paid Mughal customs and in-land taxes on their private trade. Furthermore, servants warehoused their goods in the Company's fortified settlements. Private trade goods were often transported on the Company's vessels, with armed escorts provided by the firm. Thus agents had successfully blurred the public-private distinction for private benefit.

Directors allowed the private use of Company resources because the firm gained by it. Specifically, private trade gave servants an incentive that grew with their years in office. As Richard Becher's case showed, private trade was most valuable for senior servants who had greatest authority over Company assets. This mechanism did not depend on non-verifiables such as reported cost reductions. It depended only on the servant's retaining his office or avoiding dismissal. The litmus test for remaining in office was the quality and quantity of goods sent back to England. The order lists annually sent to Bengal served as the Company's performance standard: deviations from the lists risked job loss for senior servants. Thus the benefits of private trade coupled with the threat of dismissal made the employment relationship mutually beneficial.

Analytically, the synergies described above are analogous to the reputational complementarities formalized earlier.¹⁸ In the East India Company case, the returns on the private

¹⁸The analogy with reputational complementarities is made concrete in Casas-Arce (2003).

trade of the servants depended upon their maintaining the job with the company. The dismissal policy acted as the link between inside and outside activities. If the performance inside was not satisfactory, the servant would be dismissed. This would result in his losing not only his inside compensation, but also most or all of his private trade. Here we also see that the compensation received on the outside varies with the performance of inside activities. Consequently, the discretion to perform outside activities was a crucial part of the East India Company's incentive scheme.

5 Conclusion

In this paper we expand the multitasking model to accommodate the possibility of synergies between different activities in job design problems. We argue that inside incentives are improved when an agent is given discretion to pursue outside activities if the compensation received outside depends on how well the agent performs inside. We investigate a mechanism by which outside activities complement incentives for inside activities, even though there is no technological linkage between them. Complementarities might arise when employment sustains an agent's reputation for high ability. The presence of such synergies determines the desirability of private trade.

Our analysis and interpretation of the job design problem expands the range of employment settings that can be explained by existing models. Our model is amenable to situations in which effort inside detracts from effort outside as in Holmstrom and Milgrom (1991). It is also amenable to cases in which effort outside the firm can induce greater effort within the firm. These synergies arise in a variety of cases such as the employment of faculty by US colleges and universities and the employment of overseas agents by the English East India Company. Our model thus offers a new approach that reconciles historical and contemporary jobs with the current understanding of job design.

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6 Appendix: proofs

It will be useful to start with a lemma that shows how to derive the posterior expectation of a function of ability with respect to the first period realization of output.

Lemma 7 *Consider a differentiable function $f(\eta)$ which has a finite expectation when η is normally distributed. Then,*

$$\frac{\partial E[f(\eta) \mid y_1, \hat{e}]}{\partial y_1} = (1 - \alpha) \cdot E[f'(\eta) \mid y_1, \hat{e}]$$

Proof. *The posterior distribution of ability is normally distributed with mean m and precision $h_\eta + h_\varepsilon$. Hence, we can write*

$$E[f(\eta) \mid y_1, \hat{e}] = \int_{-\infty}^{+\infty} f(\eta) \cdot \sqrt{h_\eta + h_\varepsilon} \cdot \phi((h_\eta + h_\varepsilon)(\eta - m)) \cdot d\eta$$

The derivative of the posterior expectation is then

$$\begin{aligned} \frac{\partial E[f(\eta) \mid y_1, \hat{e}]}{\partial y_1} &= \int_{-\infty}^{+\infty} f(\eta) \cdot \sqrt{h_\eta + h_\varepsilon} \cdot \frac{\partial \phi((h_\eta + h_\varepsilon)(\eta - m))}{\partial y_1} \cdot d\eta \\ &= -(1 - \alpha)(h_\eta + h_\varepsilon)^{3/2} \int_{-\infty}^{+\infty} f(\eta) \cdot \phi'((h_\eta + h_\varepsilon)(\eta - m)) \cdot d\eta \end{aligned}$$

If we integrate by parts, we obtain:

$$\begin{aligned} \frac{\partial E[f(\eta) \mid y_1, \hat{e}]}{\partial y_1} &= -(1 - \alpha)(h_\eta + h_\varepsilon)^{1/3} \left[f(\eta) \cdot \phi((h_\eta + h_\varepsilon)(\eta - m)) \Big|_{-\infty}^{+\infty} - \int_{-\infty}^{+\infty} f'(\eta) \cdot \phi((h_\eta + h_\varepsilon)(\eta - m)) \cdot d\eta \right] \\ &= (1 - \alpha) \int_{-\infty}^{+\infty} f'(\eta) \cdot \sqrt{h_\eta + h_\varepsilon} \cdot \phi((h_\eta + h_\varepsilon)(\eta - m)) \cdot d\eta \end{aligned}$$

where the last step follows from the assumption that $f(\eta)$ has a finite expectation, and hence $f(+\infty) \cdot \phi(+\infty) = f(-\infty) \cdot \phi(-\infty) = 0$. ■

The expectation of $f(\eta)$ with respect to y_1 can be easily computed as a fraction $(1 - \alpha)$ of the expectation of the derivative of the function, $f'(\eta)$. This result will be convenient for the proof of Proposition 2.

Proof of Proposition 2. *The first order conditions to the new problem are:*

$$E \left[(1 - \mu) \cdot \frac{\partial E[\underline{u}(\eta) \mid y_1, \widehat{e}]}{\partial y_1} \cdot \frac{\partial y_1}{\partial e_1} + \mu \cdot \frac{\partial \Pi_2}{\partial y_1} \cdot \frac{\partial y_1}{\partial e_1} \right] = c'(e_1)$$

where $\Pi_2 = e_2^* + E[\eta \mid y_1, \widehat{e}] + \sigma_2 \cdot E[v(i_2^*, \eta) \mid y_1, \widehat{e}] - c(e_2^* + i_2^*)$. From the production function, it is clear that $\frac{\partial y_1}{\partial e} = 1$. The first term inside the expectation is the effect of output on the outside option, which is certainly independent of σ . In order to show that effort increases when the agent has more discretion, it suffices to show that $\frac{\partial \Pi_2}{\partial y_1}$ is higher when $\sigma = 1$ than when $\sigma = 0$.

Consider first case (i). Since $v_{i\eta} = 0$, the function must be separable in (i, η) . As a result, the optimal choice of the agent has (e_2^*, i_2^*) independent of y_1 (although they will depend on σ). Hence, we obtain:

$$\frac{\partial \Pi_2}{\partial y_1} = \frac{\partial E[\eta \mid y_1, \widehat{e}]}{\partial y_1} + \sigma \cdot \frac{\partial E[v(i_2^*, \eta) \mid y_1, \widehat{e}]}{\partial y_1} = (1 - \alpha) + \sigma \cdot (1 - \alpha) \cdot E[v_\eta(i_2^*, \eta) \mid y_1, \widehat{e}]$$

where the last step follows from the application of Lemma 1 on the derivative of both expectations, and the fact that i_2^* is independent of y_1 . Finally, since $v_\eta > 0$ by assumption (which implies that $E[v_\eta(i_2^*, \eta) \mid y_1, \widehat{e}] > 0$), the above expression must be increasing in σ .

Under case (ii), (e_2^*, i_2^*) will depend on y_1 . Indeed, e_2^* is (weakly) decreasing, while i_2^* is (strictly) increasing in y_1 . It is easy to see this from the second period first order conditions:

$$\beta \leq c'(e_2^* + i_2^*) \tag{4}$$

$$E[v_i(i_2^*, \eta) \mid y_1, \widehat{e}] = c'(e_2^* + i_2^*)$$

The condition with respect to i_2 is always satisfied with equality since v_i is arbitrarily large when $i_2 = 0$. The condition with respect to e_2 is satisfied with strict equality for an interior solution $e_2^* > 0$. But in a corner ($e_2^* = 0$) solution we will typically have a strict inequality. We can then write:

$$\frac{\partial \Pi_2}{\partial y_1} = \frac{\partial e_2^*}{\partial y_1} + \frac{\partial E[\eta | y_1, \hat{e}]}{\partial y_1} + \sigma \cdot \frac{\partial E[v(i_2^*, \eta) | y_1, \hat{e}]}{\partial y_1} - c'(e_2^* + i_2^*) \cdot \frac{\partial (e_2^* + i_2^*)}{\partial y_1}$$

where $\frac{\partial E[v(i_2^*, \eta) | y_1, \hat{e}]}{\partial y_1} = (1 - \alpha) \cdot E[v_\eta(i_2^*, \eta) | y_1, \hat{e}] + E[v_i(i_2^*, \eta) | y_1, \hat{e}] \cdot \frac{\partial i_2^*}{\partial y_1}$.

From the first order conditions we can distinguish two cases. If there is a corner solution, then $e_2^* = 0$, and i_2^* satisfies the equation $E[v_i(i_2^*, \eta) | y_1, \hat{e}] = c'(i_2^*)$. It then follows, from the envelope theorem, that $\frac{\partial \Pi_2}{\partial y_1} = \frac{\partial E[\eta | y_1, \hat{e}]}{\partial y_1}$ when $\sigma = 0$, and $\frac{\partial \Pi_2}{\partial y_1} = \frac{\partial E[\eta | y_1, \hat{e}]}{\partial y_1} + (1 - \alpha) \cdot E[v_\eta(i_2^*, \eta) | y_1, \hat{e}]$ when $\sigma = 1$, this being greater than the former.

If the solution is interior, both equations in (4) are satisfied with equality. Therefore, $E[v_i(i_2^*, \eta) | y_1, \hat{e}] = c'(e_2^* + i_2^*) = \beta$. It follows that $e_2^* + i_2^*$ is constant, while i_2^* is increasing in y_1 (and, consequently, e_2^* is decreasing). Putting all this together we obtain that $\frac{\partial \Pi_2}{\partial y_1} = \frac{\partial E[\eta | y_1, \hat{e}]}{\partial y_1}$ when $\sigma = 0$, and $\frac{\partial \Pi_2}{\partial y_1} = \frac{\partial E[\eta | y_1, \hat{e}]}{\partial y_1} + (1 - \alpha) \cdot E[v_\eta(i_2^*, \eta) | y_1, \hat{e}] + (\beta - 1) \cdot \frac{\partial i_2^*}{\partial y_1}$ when $\sigma = 1$. Furthermore, differentiating the equation $E[v_i(i_2^*, \eta) | y_1, \hat{e}] = \beta$ arising from the first order conditions, we get that $\frac{\partial i_2^*}{\partial y_1} = -\frac{(1 - \alpha) \cdot E[v_{i\eta}(i_2^*, \eta) | y_1, \hat{e}]}{E[v_{ii}(i_2^*, \eta) | y_1, \hat{e}]}$. The second period payoff will then be more responsive to y_1 whenever $E[v_\eta(i_2^*, \eta) | y_1, \hat{e}] > (\beta - 1) \cdot \frac{E[v_{i\eta}(i_2^*, \eta) | y_1, \hat{e}]}{E[v_{ii}(i_2^*, \eta) | y_1, \hat{e}]}$. The conditions in the proposition ensure this is just satisfied.

This concludes the proof. ■

Proof of Proposition 3. In case the outside activity is not allowed, the model collapses to the standard career concerns model of Holmstrom (1982). The marginal return on effort is $(1 - \alpha)$, which is independent of $\hat{e}$. As a result, this is the unique equilibrium $e^*(0)$. When the outside activity is allowed, notice that for any belief $\hat{e}$ the agent chooses a positive level of effort, $e^*(\hat{e}, \sigma) > 0$. This is true even when $\hat{e} = 0$. Moreover, from Proposition 2, $e^*(\hat{e}, 1) > e^*(\hat{e}, 0) = e^*(0)$ for any $\hat{e} \geq 0$. Therefore, any equilibrium when

$\sigma = 1$ satisfies $e^*(1) > e^*(0)$. ■

Proof of Proposition 4. It is optimal to set $\sigma = 1$ whenever the benefits of allowing the outside activity outweigh the costs. The benefit of discretion consists of the outside rents, $E[v(i_2^*, \eta) \mid y_1, \hat{e}]$. The cost is the decrease in inside output that results from the limited attention, $e_2^*(0, y_1) - e_2^*(1, y_1)$, together with the possible increase in the cost of total effort, $c(e_2^*(1, y_1) + i_2^*(1, y_1)) - c(e_2^*(0, y_1))$. (Notice we do not take into account the incentive effect of σ of first period effort, as the discretion policy is set in period 2.) In other words, the welfare from implementing $\sigma = 1$ is: $Welfare = \Pi_2 \mid_{\sigma=1} - \Pi_2 \mid_{\sigma=0}$. From the proof of proposition 1 it follows that $\frac{\partial \Pi_2}{\partial y_1} \mid_{\sigma=1} > \frac{\partial \Pi_2}{\partial y_1} \mid_{\sigma=0}$ under conditions (i) or (ii). As a result, welfare is increasing with y_1 , and the principal will find it optimal to set σ increasing in y_1 . ■

Proof of Proposition 5. To show part (a), assume that $\underline{u}'(\eta) > 1$. Expected inside output in the second period is $E[y_2 \mid y_1, \hat{e}] = e_2^* + E[\eta \mid y_1, \hat{e}]$. When $\sigma = 0$, e_2^* does not depend on y_1 . Hence, only the term $E[\eta \mid y_1, \hat{e}]$ depends on y_1 . Given that $\underline{u}'(\eta) > 1$, there exists a $\hat{\eta}$ such that $\underline{u}(\eta) > \eta$ if and only if $\eta > \hat{\eta}$.

We can express $E[\underline{u}(\eta) \mid y_1, \hat{e}]$ and $E[\eta \mid y_1, \hat{e}]$ as a convex combination of the partial expectations as follows:

$$\begin{aligned} E[\underline{u}(\eta) \mid y_1, \hat{e}] &= \Pr(\eta \leq \hat{\eta} \mid y_1, \hat{e}) \cdot E[\underline{u}(\eta) \mid y_1, \hat{e}, \eta \leq \hat{\eta}] \\ &\quad + \Pr(\eta > \hat{\eta} \mid y_1, \hat{e}) \cdot E[\underline{u}(\eta) \mid y_1, \hat{e}, \eta > \hat{\eta}] \\ E[\eta \mid y_1, \hat{e}] &= \Pr(\eta \leq \hat{\eta} \mid y_1, \hat{e}) \cdot E[\eta \mid y_1, \hat{e}, \eta \leq \hat{\eta}] \\ &\quad + \Pr(\eta > \hat{\eta} \mid y_1, \hat{e}) \cdot E[\eta \mid y_1, \hat{e}, \eta > \hat{\eta}] \end{aligned}$$

where $E[\cdot \mid y_1, \hat{e}, \eta > \hat{\eta}]$ denotes the expectation over the posterior distribution of ability (after observing y_1) given that $\eta > \hat{\eta}$; and similarly for $E[\cdot \mid y_1, \hat{e}, \eta \leq \hat{\eta}]$.

Notice that $E[\underline{u}(\eta) \mid y_1, \hat{e}, \eta > \hat{\eta}] > E[\eta \mid y_1, \hat{e}, \eta > \hat{\eta}]$. Furthermore, for y_1 sufficiently large (namely, $y_1 \geq \hat{y}$), we can make both terms $\Pr(\eta \leq \hat{\eta} \mid y_1, \hat{e}) \cdot E[\underline{u}(\eta) \mid y_1, \hat{e}, \eta \leq \hat{\eta}]$ and $\Pr(\eta \leq \hat{\eta} \mid y_1, \hat{e}) \cdot E[\eta \mid y_1, \hat{e}, \eta \leq \hat{\eta}]$ arbitrarily small. It then follows that $E[\underline{u}(\eta) \mid y_1, \hat{e}] > E[\eta \mid y_1, \hat{e}]$.

Part (b) of the proposition proceeds in analogous steps. ■

Table 1
Multitasking in Faculty Employment

This table provides basic statistics for the relation between inside and outside activities. The first column shows the correlation between the amount of time spent on research (in % of work time per week) and the outside income (in \$/year) corresponding to each activity. The second column reports the statistical significance of these correlations in separate regressions. It reports the coefficients of the OLS regression of income from one outside activity on research effort plus a constant. The third column reports the average time spent on research for those faculty members that receive a positive amount of income from the corresponding outside activity. To explore the differences in these means, column four reports the OLS regression of research effort on a constant and a set of dummy variables for each outside activity. They take a value of 1 if the faculty member receives positive income from that activity and zero otherwise. (The omitted constant takes a value of 12.922, with a t-statistic of 63.68.)

	Relationship between Research Effort and Outside Income		Relationship between Research and Participation in Outside Activity	
	Correlation w/ Research Effort	Regression Coefficient	Mean Effort in Research	Regression Coefficient
Another Academic Institution	-0.071	-35.476 (12.24)***	8.163	-4.509 (13.12)***
Other Employment	-0.112	-105.856 (18.81)***	7.550	-6.139 (20.74)***
Legal/Medical Services	-0.024	-9.920 (4.66)***	11.012	-2.800 (4.23)***
Self-owned Business	-0.045	-14.663 (7.70)***	8.946	-3.680 (7.22)***
Outside Consulting	0.050	17.894 (6.27)***	15.692	2.276 (6.42)***
Speaking Fees	0.084	4.317 (10.96)***	19.375	6.225 (14.01)***
Royalties	0.071	6.006 (7.84)***	21.742	7.106 (12.57)***
Grants	0.069	5.982 (4.27)***	28.362	14.145 (5.98)***

Robust t statistics in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 2
Outside Income and Research Effort

This table reports OLS regressions of Income from Outside Activities (in \$/year) on Effort in Research (as % of work time per week) and controls. In each regression, the dependent variable corresponds to the income received from outside activities corresponding to the category in the column heading. The controls include the total amount of time spent on outside activities (in hours/week), the salary at the institution, experience (measured as the number of years teaching), and dummies for rank, teaching field and institution.

	Another Academic Institution	Other Employment	Legal / Medical Services	Self-owned Business	Outside Consulting	Speaking Fees	Royalties	Grants
Time on Research	8.047 (2.22)*	-46.773 (6.48)**	-14.185 (4.29)**	-6.297 (2.41)*	2.866 (0.78)	1.271 (2.57)*	3.733 (3.81)**	3.214 (2.19)*
Time on Outside Activities	141.654 (13.52)**	436.828 (22.35)**	42.827 (5.64)**	55.657 (7.75)**	82.552 (12.94)**	8.122 (10.01)**	5.735 (5.41)**	0.501 (0.43)
Salary	-0.036 (9.20)**	-0.092 (10.61)**	-0.026 (6.01)**	-0.010 (4.34)**	0.022 (6.08)**	0.004 (7.46)**	0.004 (6.34)**	-0.002 (2.46)*
Experience	34.351 (3.58)**	-7.096 (0.42)	26.808 (3.41)**	31.854 (4.73)**	1.563 (0.21)	0.265 (0.28)	8.266 (5.00)**	-1.312 (1.08)
Other Controls:								
Rank	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Field	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Institution	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	18043	18043	18043	18043	18043	18043	18043	18043
R-squared	0.16	0.27	0.15	0.11	0.13	0.13	0.08	0.05

Robust t statistics in parentheses

* significant at 10%, ** significant at 5%; *** significant at 1%

Table 3
Limited Attention and Research Effort

This table reports OLS regressions of Effort in Research (as % of work time per week) on Time on Outside Activities (total for all outside activities, in hours/week) and controls. We also interact Time on Outside Activities with eight dummy variables for each of the types of outside activities, which take a value of 1 whenever the faculty member receives positive income from this type of activity. Column (1) uses only these explanatory variables, without any controls. Column (2) adds the salary at the institution, experience (measured as the number of years teaching) and dummies for rank and field. Dummies for institution are introduced in column (3).

	(1)	(2)	(3)
Time on Outside activities	-0.175 (11.24)***	-0.031 (1.95)*	-0.045 (2.79)***
Another Academic Institution	-0.035 (2.30)**	0.027 (1.85)*	0.052 (3.50)***
Other Employment	-0.088 (6.04)***	-0.038 (2.72)***	-0.022 (1.56)
Legal/Medical Services	-0.017 (0.68)	-0.031 (1.17)	-0.052 (1.86)*
Self-owned Business	-0.060 (3.55)***	-0.029 (1.71)*	-0.014 (0.78)
Outside Consulting	0.065 (3.88)***	0.042 (2.62)***	0.038 (2.30)**
Speaking Fees	0.158 (6.57)***	0.099 (4.22)***	0.058 (2.47)**
Royalties	0.268 (6.40)***	0.181 (4.73)***	0.101 (2.66)***
Grants	0.473 (1.60)	0.378 (1.29)	0.397 (1.42)
Salary		0.000 (14.49)***	0.000 (3.66)***
Experience		-0.175 (11.11)***	-0.148 (9.58)***
Other Controls:			
Rank	No	Yes	Yes
Field	No	Yes	Yes
Institution	No	No	Yes
Observations	18043	18043	18043
R-squared	0.03	0.27	0.39

Robust t statistics in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%