Job Design and the English East India Company

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Abstract

A forerunner of the modern corporation, the English East India Company provides a counterexample to the job design theory of Holmstrom and Milgrom (1991). Holmstrom and Milgrom (1991) argue that when an agent is not financially responsible for the principal's output, he should be not be allowed to pursue outside activities during company time. In the East India Company and other employment settings, though, those activities are allowed despite poor monitoring technologies, and weak incentives.

We offer a model of the job design problem in which the reward from outside activities is affected by the performance on the inside activity. In this case, the two activities can become strategic complements and increase overall incentives. As such, the model provides a rational for the existance of synergies between different activities.

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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 analyzing a wide range of contractual instruments including incentive pay, asset ownership, and job design, they expand the standard principal-agent model to address the allocation of agents' effort across a range of tasks. In the area of job design 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, 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 to an agent earning private compensation on company time. Holmstrom and Milgrom 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 the reduction in effort. Hence allowing outside activities becomes optimal only when the agent is financial responsibility for inside activities. The absence of performance incentives (which frequently occurs where good performance measures are missing or where monitoring costs are prohibitive) renders outside activities inefficient.

Recent empirical studies have underpinned the Holmstrom and Milgrom result. Cockburn, Henderson, and Stern (1999, NBER working paper 6882) explore the balance of incentives faced by researchers in private pharmaceutical firms. Margaret Slade's findings on service stations in the city of Vancouver are also supportive.

By contrast, we present an important historical case that does not accord with the Holmstrom and Milgrom 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.[1] Anderson et. al. (1983) and Carlos and Nicholas (1988) have argued that in the seventeenth and eighteenth century the East India Company was an organizational innovation on par with a modern multinational firm such as General Motors. 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 have a constructed a database that tracks the careers of every agent sent to Bengal, India in the

[1] See for example Harris (2000) *Industrializing English Law*, Alborn (1999) C*onceiving Companies*, and Baskin and Miranti (1996) *History of Corporate Finance*.

eighteenth century. The data enable us to comprehensively describe the employment relationship linking Company directors and their overseas servants. We find that the Company offered servants, separated by more than sevens 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 Holmstrom and Milgrom, any concession on outside activities inefficient. Yet we observe that the Company allowed and actively encouraged the servants to conduct their own trades. Company directors recognized and made use of the complementarities between public and private trade. This case calls for a different approach to the job design problem.

We next provide a theoretical discussion of the conditions under which the observed design (involving a fixed wage and the right to conduct private trade) appears to be desirable even when strong performance incentives cannot be provided. We develop a two period model where output is produced with effort and ability, in the spirit of Holmstrom's career concern model (Holmstrom, 1982, 1999). We assume that output is observable but non-verifiable. Therefore, contracts can only specify an uncontingent wage, and whether outside activities are allowed. Despite not having explicit incentives, the agent will exert effort in the first period to try to convince the principal she has high ability. We start assuming that outside activities require an initial investment in period one, and pay off in the second period. In that case, we show that when ability is an input for both inside and outside activities, incentives for effort get increased when the agent is allowed to benefit from the latter. Now, not only the agent receives the reward of a higher wage, but returns from outside activities get increased when output inside is higher. Allowing more freedom to the agent to exploit the returns from a reputation for high ability increases the incentives to acquire that reputation in the first place. We show that the higher the dependence of the outside activity on ability, the stronger the synergies between the two tasks, and the more effort is increased inside.

The analysis implicitly assumes that outsiders are able to observe the principal's output. When that is not the case, the outside market faces an asymmetric information problem. This reduces the extent to which outsiders will be able to judge ability, and hence the incentive effect of outside activities gets reduced. However, we show it does not completely disappear. Dismissals of those agents who perform poorly will reveal information to the market. Therefore, those who remain working for the principal in the second period will enjoy higher benefits from outside activities. In this case, also, outside activities increase incentives. As a result, the cost of implementing a certain level of effort decreases, since a lower second period wage is required.

Finally, we explore the possibility of learning about ability from outside activities. For that purpose

we modify the model assuming outside activities also require effort each period, instead of an investment. In this case, even though there is no technological linkage between the two activities, effort in inside activities can either increase or decrease, with respect to the case without outside activities. Effort will be higher the higher the precision of the signal about ability from inside activities, and the more outside activities depend on ability. The comparative statics derived from the basic model are then robust to the introduction of learning about ability from outside activities.

Our model extends Holmstrom and Milgrom's analysis of job design problems. They emphasize the role of limited attention in the creation of a conflict of interest for the agent when outside activities are allowed. However, when output produced by the agent depends on ability, her reputation becomes important, and synergies may arise between the two activities even when they are technologically independent. Recently, Dewatripont et.al. (1999b) have studied a similar multitask career concern model to ours aimed at understanding the incentives of government agencies. However, they are only interested in the incentive effects of the number of activities carried out by a single agency. For that reason, they consider a model where all the activities are symmetric, and only total effort matters (but not how that effort is distributed among each activity). 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.[2] 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 what 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 payoff reflects her increased responsibilities.

The rest of the paper is organized as follows. Section 2 presents an account of the employment relationship in the East India Company. The wage structure, the permission to trade privately, dismissal policy, and other enforcement instruments will be described. Section 3 provides a formal articulation of the job design problem taking into account many of the features observed in the historical record. We model the main features of the contracts and evaluate the optimality of allowing private trade. Section 4 discusses the model in the context of our historical case. We also draw parallels between the model and employment relationships in U.S. higher education. And finally, section 5 concludes and identifies lines of future research.

[2] There is an indirect effect, though, since the number of activities affects the process of learning about ability.

2 Job design: an historical account

In this section we overview the employment relation in the East India Company. The main features of the contract design used by the Company are then analyzed.

2.1 Overview of the employment relationship

Between 1700-1774 the Directors sent 682 employees or servants to Bengal, the Company's principal input market.[3] In India the servants engaged in a variety of transactions directed at the provision of the "investment" and management of Company assets.[4] 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, and negotiating with the Bengal governor or his representatives. The challenge facing the Directors was to prevail upon the servants to undertake those tasks in the interests of the Company.

Two main factors undermined the Directors' ability to do so: the distance separating the two parties and the mortality risks faced by the servants. The outbound voyage took from 7 months to a year. Total transportation time by sea, therefore, was between one-half and two years. This was the length of time required for goods and information to reach the Directors. The Company, consequently, had to face the problem of deciding if the servants' actions taken more than half a year ago in India reflected "mature consideration" or malfeasance. Such lags in delivery and communication saturated the relationship with informational asymmetries. The Company addressed the informational problems by requiring documentation accounting for all aspects of their operations. The Directors imposed strict demands with respect to reporting standards. Such documentation included detailed correspondence, accounting ledgers, minutes of meetings, diaries, etc.

This correspondence provides an invaluable source of information for scholars of the history of the East India Company. We use it to obtain information (compile a data set containing details) about the servants, from which this study is based. This information contains dates of arrival and departure, reasons for departure, positions held at every point in time, among other variables.

An additional exogenous constraint on the enforcement of the employment contracts was the high degree of mortality of Europeans in Asia. Death in active service accounted for 348 or roughly 51%

[3] For a more detailed account of the employment relationship in the EIC see Hejeebu (2002). Chaudhuri (1978) describes the organization of the Company and its trading system. Marshall (1976) documents the private trade of servants in India.

[4] The Company referred to its "investment" as the goods that were purchased in India and later sold in London. Because the English produced few goods demanded in India, they had to trade bullion for Bengali textiles, raw silk, and saltpetre.

of the departures from employment. As can be seen in Figure 1, mortality affected employment most crucially in the first ten 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. It increased the opportunity cost of joining the East India Company versus joining a mercantile, banking, or law firm within England. The adverse implications of the mortality risks had to be offset by large compensation packages. Young men joined the firm hoping to beat the mortality odds and to acquire an "independence" or a "competency," a nest-egg for their retirement.

2.2 Contract Incompleteness

Before starting to describe the formal contracts, it is worth mention they lack clear specification of what was expected of the employee in a variety of states. Indeed, the information lags and the complexity of the tasks to be performed in India made them certainly incomplete. The employment contracts, called "covenants of indenture," provide only a vague idea of what the employee actually did. Despite their great length, restrictive tone, and careful wording of legal rights and responsibilities, the contracts reveal that the Directors could neither anticipate nor operationalize a best response for the wide variety of market transactions the servants would encounter. Both the initial contracts and the ongoing correspondence left a great decision-making in the hands of the servants in Bengal.

In a letter to the Bengal President and Council, dated 11 February 1731/32, the Directors write, "Having thus far acquainted you with our thoughts by ordering some things positively and leaving others in a manner to your own discretion, we expect as to the first a strict compliance and to the last your reasons why you differ from us in opinion" (para. 126). The Directors referred to their procedural rules as "positive orders." Although they expected close adherence to the "positive orders" they provided the following caveat " 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" (para. 77).[5] In countless cases, the judgment of the President and Council alone determined outcomes for the Company.

[5] The 42-paged letter of 11 February 1731/2 belongs to a set of twenty years of correspondence examined for this project. Typically the early years of each decade in the period were chosen. For each year there was at least one General Letter to the President and Council. The letter of 11 February 1731 was written shortly after dismissing President John Deane for persistent returns of low quality goods. The letter reveals the Directors' frustration with Deane's successor. Because it illustrates the range and depth of information problems and in order to avoid jumping from context to context, the letter of 11 February 1731/2 will be referred to on several instances.

2.3 Wage structure

The incentive scheme specified in the contract 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 of increasing responsibility: writer, factor, junior merchant, and senior merchant. A writer earned £5 per year. After 5 years he was promoted to the rank of factor and received £15 per year. After 3 years he qualified for promotion to junior servant at £30 per year. After another 3 years he could become senior merchant earning £40 per year. These salaries were paltry by the standards of the other chartered companies and by the standards of middle class England in the eighteenth century, though (Carlos 1994, 324; Carlos and Nicholas 1993, 245; Williamson 1982, 48; Langford 1989, 63; Grassby 1995, 258-262). Williamson (p.48) estimated that in 1737, barristers and solicitors earned annually £178 and bank, commercial, or law clerks £68. Langford (p.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.

2.4 Private Trade

The crucial incentive clause was tucked deep in the middle of the contract: "the said Company doth accordingly license the said [servant's name] freely to trade and traffic for his own account only, from port to port in India, or elsewhere within the limits aforesaid without any let, hindrance, or interruption from them the said Company."[6] The private trade clause acknowledged and lent support to the servants' pursuit of fortune. It injected an entrepreneurial element in the servants' and thus the Company's activities in Asia. As Watson (1977, 77) describes, the Company came to believe that "the advantages of a thriving private trade in the Indian settlements lay in the attractions for population, which in turn led to better defensive postures and increased revenues through civil levies, quit rents, ground rents, and customs duties."

In addition to permitting private trade, the Directors after 1714 provided a mechanism for remitting money home: bills of exchange. The bill simply transferred money from one person to another via the Company. Servants deposited rupees in the Company's treasury in Calcutta and the Company paid the sterling equivalent to beneficiaries in London. In a letter to the Directors in 1716 Joseph Collet

[6] O/1/1 covenant of John Hall. After a series of attempts to allow limited private trade in the 1670s, the Company shifted to a system of complete freedom of trade in the Indies by 1680. The historian Ian Watson (1980, 74) emphasizes (1) the lack of profitability of using Company ships for the "country" or intra-Asian trade and (2) the inability of the directors to enforce a prohibition of private trade as the main reasons for its sanction. By contrast, we argue that the on-going allowance of private trade followed a compelling economic logic.

explained that servants found the Company bills desirable "for sake of security and speedy payment and because it would be a service to provide the Company's cash" (E/4/2 p.90).

Based on aggregate annual flows of remittances and the number of persons making remittances each year, Hejeebu (2002) confirms the opinion of many historians: EIC servants indeed made fortunes in private trade. By individually tracking the roughly 1500 bills of exchange issued on the Company in Bengal between 1747 and 1756, she estimates that the English community annually remitted £297 on average per person. It should be noted that the amounts remitted represent a fraction of actual earnings. They correspond to net savings and do not include consumption expenditure or investments kept in India.

Most importantly the Directors enabled the servants to use Company assets in pursuing private trade. Besides the convenience of the bills of exchange mentioned above, the Company provided increased security from its army and its fortified settlements. Individuals also profited from the Company's reputation as a long-lived actor that would guarantee its employees' private debts. The servants also made full use of the Company's trading privileges, negotiated with the Mughal court in Delhi and applicable over the region of Bengal. The most notable of such privileges was the *firman* of 1717. Awarded by the Mughal Emperor Faruksiyar, the *firman* or imperial grant gave the Company the right to trade in Bengal free of customs and in-land transit tax in exchange for an annual payment of Rs. 3,000.[7] Even though the agreements were not originally intended to apply to the private trade of the servants, the servants made extensive use of these privileges for their own profit. Such access to corporate resources gave Company servants competitive advantages over other traders and enabled them to enjoy large quasi-rents. Those benefits could only be enjoyed to the extent the they remained in service. Effectively, returns from private trade were linked to the employment with the company.

2.5 Dismissal policy

The Director's most effective punishment against servants' violating contractual norms was dismissal. Among the 682 persons who entered the Bengal service from 1700 to 1774, 60 (8.8%) were dismissed, suspended, or transferred. As Figure 2 indicates, dismissals occurred most frequently at the highest levels of responsibility, the senior servants. Yet it was the senior servants who had the most to lose from having their employment relationship severed. The senior servants had the most specific investments made in the relationship. By the time a servant reached the highest rank, he would have

[7] This corresponds to about £375 on a volume of purchases averaging over £300,000 per year between 1717 and 1760 for textiles alone (Chaudhuri 1978, 544-545).

nurtured long-term relationships with Indian creditors, brokers, and suppliers. He would have acquired intimate knowledge about local market conditions. He would have developed a mature understanding of local trading conventions, currencies, and weights and acquired some facility in the local languages. By the time a person reached a senior rank, he could reap the dividends of his specific investments in the both private and Company trades.

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 a serious way to discipline powerful veterans. By failing to exert himself in the Company's business, a servant jeopardized his membership in the Company plus all the private benefits membership might bring.

2.6 Other enforcement mechanisms

Besides the fixed wage, private trade, and dismissal policies, did the firm employ other instruments to sustain the contractual relationship? Given the formality of the relationship and the financial stakes involved, one might imagine that the Company made regular recourse to the English legal system in order to limit the opportunistic behavior of overseas employees. This was not the case, though. The Company had two legal instruments from which to act: the covenant and the bond. The "covenant of indenture" was the formal contract. In it the Directors specifically warn that in the event that the terms of the covenant were not honored the Company would sue the servant in the Court of Chancery or Exchequer. The second instrument was a pre-employment bond, signed by two sureties on the employee's behalf. The sureties promised to the pay the Company the face value of the bond in the event the servant violated the terms of the covenant.[8]

Theoretically such practices involving third party enforcement and liability could provide a deterrence against malfeasant behavior and insurance up to the value of the bond. Hejeebu (2002) argues

[8] Bond values began at £500 for the rank of writer, £1,000 for factor, £2,000 for junior merchant, £4,000 for senior merchant, and £10,000 for the position of governor (O/L/1-O/L/27). Bonding within the Hudson's Bay and Royal African companies is described in Carlos 1992, 1994.

however that prosecution in the Courts was seldom pursued. Of the Chancery cases she examined, not a single instance of legal action against a bond sponsor was evident. The Company did initiate suits against servants who returned to England but rarely so. In an internal memo dated 1785 the Company's solicitor could not explain the reasons for bonding. When asked to explain the practice, he and the Company's Secretary indicated "the form of the covenant had in this respect been ever what it now is and that there had at first been some good cause for it but they did not intimate even a guess what it might be" (HMS vol 79, 99 43-60). The Company apparently preferred dismissing or suspending rogue employees rather than suing their sponsors and often withheld the reasons for dismissal "least the persons affected should sue for damages, and the reasons assigned not held justifiable in a court of law." The Company clearly preferred to use enforcement mechanisms from within the firm than those from without.

3 Job Design: A Formal Account

In this section we present a formal model of outside activities. We explore the conditions that would make allowing such activities 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 to relax the assumptions of the basic framework, and we derive several comparative statics.

3.1 The Setup

A risk neutral principal (the Company) hires a risk neutral agent[9] (a servant that would be located in India) for a maximum of two periods to conduct public trade. Output in either period can take two values, $y_t \in \{\overline{y}, \underline{y}\}$, with $\overline{y} > \underline{y} \geq 0$. Let e_t represents effort and η_t the ability of the agent. We will denote $p(e_t, \eta_t) \in [0,1] = \Pr\{y_t = \overline{y} \mid e_t, \eta_t\}$ as the probability of high output (the same for both periods), which is assumed to be strictly increasing in both arguments and concave in e_t. Ability is uncertain, but both principal and agent share the same (symmetric) information. For simplicity, it can take two values $\eta_t \in \{\overline{\eta}, \underline{\eta}\}$, with ex-ante probability μ of being high ability. Output is assumed to be observable but non-verifiable.

Besides the involvement in public (inside) activities, the principal might allow the agent to conduct private (outside) trade. Such activity requires an initial investment (at time $t = 1$), denoted by i, which is observable, and at period 2 generates a value of $v(i, \eta_2)$, which is strictly increasing in both arguments

[9] To avoid any confusion, we will refer to the principal as "he," and to the agent as "she."

and concave in i. Since ability is uncertain, though, the actual return for the agent from the outside activity is $E\left[v\left(i,\eta_2\right) \mid \text{outsider's information}\right]$.[10]

For the sake of simplifying notation we will make the following conventions: $p'\left(e_t,\eta_t\right) = \frac{\partial p(e_t,\eta_t)}{\partial e_t}$ and $v'\left(i,\eta_2\right) = \frac{\partial v(i,\eta_2)}{\partial i}$. To guarantee an interior solution we assume $p'\left(e_t,\eta_t\right) \to +\infty$ as $e_t \to 0$, and $v'\left(i,\eta\right) \to +\infty$ as $i \to 0$.

Since output is non-verifiable, the agent will not face any incentive in the final period. It then follows that the optimal effort level at time $t = 2$, e_2^*, will be a constant.[11] And as a result, we do not need to consider any explicit cost function for period 2. We will also drop the time subindex for e_1, since only first period effort will be relevant. Total costs for the agent at $t = 1$ will then be $c\left(e,i\right)$, which is assumed to be convex in both variables. We will look at two cases. Case 1: When $c\left(e,i\right) = c\left(e+i\right)$ the agent has limited attention (increasing effort in one task increases the marginal cost of the other task). Following Holmstrom and Milgrom (1991), the agent will work to some extent even in the absence of incentives. For that to be true, we assume the cost function is decreasing up to some $\overline{k} > 0$, i.e. $c'\left(k\right) \leq 0$, for all $k \leq \overline{k}$. Case 2: With a separable cost function, $c\left(e,i\right) = c_e\left(e\right) + c_i\left(i\right)$, the two activities are unrelated.[12]

Finally, the principal has several instruments to provide incentives to the agent. He can set a wage for each period, $\{w_1, w_2\}$. He can also design the restrictions imposed on the job, which in this case correspond to whether the agent is allowed to trade freely on her account, i.e., $\sigma \in \{0,1\}$, where $\sigma = 1$ means the agent has been granted that privilege. Finally, the Company can decide the termination of the relationship after the first period, conditional on first period output. If termination occurs, principal and agent enjoy a last-period payoff of 0 and $\underline{u} \geq 0$, respectively.

We will assume there is perfect competition, and hence, the agent can obtain a wage equal to her expected productivity in the market. Moreover, the agent can still obtain the rents from outside activities if they were allowed in the first place (i.e., $\sigma = 1$), even if there is termination of the relationship after the first period. This results in an outside option (for period 2) of $\underline{u} = E\left[y_2 \mid \text{outsider's information}\right] + \sigma \cdot E\left[v\left(i,\eta\right) \mid \text{outsider's information}\right]$.

To sum up, we outline the timing of the model. The principal initially offers the agent a contract. Upon acceptance of the contract the agent is hired. The agent works during the first period for a fixed

[10] It is implicitly assumed 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 offers this compensation to the agent.

[11] Either $e_2^* = 0$ if the cost function is strictly increasing, or $e_2^* > 0$ if it decreases initially, as we will assume for the first period. This, though, is irrelevant for what follows.

[12] In this case, whether we assume the cost functions are initially decreasing or not is irrelevant for what follows.

wage (paid ex-ante), and invests in outside activities if she is allowed to do so. Output is then realized. The principal forms an expectation of the effort level of the agent, and together with the realization of output he infers a level of ability. In equilibrium, such expectation will equal the true level of effort chosen by the agent (which in turn will depend on the effort level expected by the principal). After this, we move to the second period. depending on the reputation acquired during the first period, the agent will then be rehired and paid a fixed wage. These second period employment and compensation conditions, though, will depend on the assumptions regarding the observability of output by outsiders and renegotiation of long-term contracts. We discuss all these possibilities in the next two sections.

3.2 Observable Output

We start with the case of output being observable by the outside market. Because of perfect competition, the agent gets paid her expected productivity, and there is no reason to consider the possibility of dismissals. This case corresponds to the career concerns model analyzed by Holmstrom (1982). The agent then receives wages $w_1 = E[y_1]$ and $w_2(y_1) = E[y_2 \mid y_1]$. where the expectation is taken with respect to η.

We start with the conditions under which Holmstrom and Milgrom's assertion that outside activities crowd out effort inside hold. Given the principal's belief about effort, denoted by $\widehat{e}$, the agent solves the following problem:

$$\max_{e,i} \left\{ \begin{array}{c} w_1 - c(e+i) + \delta E[p(e,\eta)] \cdot (w_2(\overline{y}) + \sigma \cdot E[v(i,\eta) \mid \widehat{e}, \overline{y}]) \\ +\delta(1 - E[p(e,\eta)]) \cdot \left(w_2\left(\underline{y}\right) + \sigma \cdot E\left[v(i,\eta) \mid \widehat{e}, \underline{y}\right]\right) \end{array} \right\} \tag{1}$$

In the first period, the agent receives a fixed wage, and decides the levels of effort and investment. Output gets realized and we move to the second period. She then receives the second period wage (contingent on first period output), and, if applicable, the returns from the investment in the outside activity. 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:

$$\delta \cdot E_\eta\left[p'(e,\eta)\right] \cdot \left(\begin{array}{c} w_2(\overline{y}) + \sigma \cdot E_\eta[v(i^*,\eta) \mid \widehat{e}, y_1 = \overline{y}] - \\ -w_2\left(\underline{y}\right) - \sigma \cdot E_\eta\left[v(i^*,\eta) \mid \widehat{e}, y_1 = \underline{y}\right] \end{array} \right) \leq c'(e+i^*) \text{ with } e^* = 0 \text{ if inequality strict} \tag{2}$$

This condition simply states that marginal return should equal marginal cost in an interior solution. A higher effort level will increase the probability of high output, and with it, the chances of acquiring a reputation for high ability. The incentives to do so will come from the difference in payoffs after high and low first period output, which is given by the expression in parenthesis.

We begin by studying the cases where ability does not play a big role. Suppose η_1 and η_2 are independent realizations of the previous distribution, or alternatively, $\eta_1 = \eta_2$ constant (and known ex-ante). In either case, the first period realization of output provides no additional information about second period ability. Then, both $E\left[v\left(i,\eta\right) \mid \widehat{e}, y_1 = \overline{y}\right]$ and $E\left[v\left(i,\eta\right) \mid \widehat{e}, y_1 = \underline{y}\right]$ are independent of y_1, and therefore equal. The same is true for $w_2\left(y_1\right)$: $w_2\left(\overline{y}\right) = w_2\left(\underline{y}\right)$. The first order condition when no outside activity is allowed is then $c'\left(e\right) = 0$, and the optimal effort level is $\overline{k}$. However, when the outside activity is allowed, $i^* > 0$. Therefore, (**??**) becomes $c'\left(e + i^*\right) > 0$, and no effort will be put into public trade.

Similarly, when returns from the outside activity are independent of ability (i.e., $v_\eta\left(i,\eta\right) = 0$), and we can simply write $v\left(i\right)$). The marginal return to effort becomes $\delta \cdot E\left[p'\left(e,\eta\right)\right] \cdot \left(w_2\left(\overline{y}\right) - w_2\left(\underline{y}\right)\right)$, independently of whether outside activities are allowed or not. However, when outside activities are allowed the agent will choose a positive investment level, and hence, marginal cost increases. This results in the outside activity reducing effort inside.

The following proposition summarizes this:

Proposition 1 *Suppose the agent has limited attention. Then, for a fixed belief about effort $\widehat{e}$, allowing the outside activity always substitutes effort away from the inside activity in the following cases:*

i. ability is constant ($\eta_1 = \eta_2$) and known

ii. ability is independent across periods (i.e., η_1, η_2 i.i.d.)

iii. outside activity independent of ability (i.e., $v_\eta\left(i,\eta\right) = 0$)

This proposition corresponds to Holmstrom and Milgrom'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.

Persistent ability

We now turn to the case where ability plays a more central role. We will assume $\eta_1 = \eta_2$, but

uncertain ex-ante[13]. Both principal and agent will learn about ability from the first period output. So will do outsiders, since they can also observe output. To simplify the exposition of the main ideas we will assume away the effects of limited attention, using a separable cost function (except when explicitly mentioned).

Conditional on the conjecture the principal has about the effort level of the agent, $\widehat{e}$, the update of beliefs at the beginning of period 2 takes the following form:

$$\begin{aligned}
\mu^2(\widehat{e}) &= \Pr\{\eta = \overline{\eta} \mid y_1 = \overline{y}\} = \frac{\mu p(\widehat{e}, \overline{\eta})}{\mu p(\widehat{e}, \overline{\eta}) + (1-\mu) p(\widehat{e}, \underline{\eta})} > \mu \\
\mu_2(\widehat{e}) &= \Pr\{\eta = \overline{\eta} \mid y_1 = \underline{y}\} = \frac{\mu(1 - p(\widehat{e}, \overline{\eta}))}{\mu(1 - p(\widehat{e}, \overline{\eta})) + (1-\mu)(1 - p(\widehat{e}, \underline{\eta}))} < \mu
\end{aligned}$$

The agent still solves the same problem (1). However, the expectations now reflect the learning about ability. Expected output after a high first period realization is $E[y_2 \mid \widehat{e}, y_1 = \overline{y}] = \underline{y} + E[p(\widehat{e}, \eta) \mid y_1 = \overline{y}] \cdot (\overline{y} - \underline{y})$, where $E[p(\widehat{e}, \eta) \mid y_1 = \overline{y}] = p(\widehat{e}, \underline{\eta}) + \mu^2(\widehat{e}) \cdot (p(\widehat{e}, \overline{\eta}) - p(\widehat{e}, \underline{\eta}))$. Similarly, after a bad realization, expectations become $E[y_2 \mid \widehat{e}, y_1 = \underline{y}] = \underline{y} + E[p(\widehat{e}, \eta) \mid y_1 = \underline{y}] \cdot (\overline{y} - \underline{y})$, with $E[p(\widehat{e}, \eta) \mid y_1 = \underline{y}] = p(\widehat{e}, \underline{\eta}) + \mu_2(\widehat{e}) \cdot (p(\widehat{e}, \overline{\eta}) - p(\widehat{e}, \underline{\eta}))$. It follows from this that $w_2(y_1)$ is strictly increasing in y_1. Moreover, compensation from the outside activity is either $E[p(\widehat{e}, \eta) \mid y_1 = \overline{y}] = p(\widehat{e}, \underline{\eta}) + \mu^2(\widehat{e}) \cdot (p(\widehat{e}, \overline{\eta}) - p(\widehat{e}, \underline{\eta}))$ or $E_\eta[v(i, \eta) \mid \widehat{e}, y_1 = \underline{y}] = v(i, \underline{\eta}) + \mu_2(\widehat{e}) \cdot (v(i, \overline{\eta}) - v(i, \underline{\eta}))$, depending on the outcome from the first period.

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, as the next proposition show:

Proposition 2 *Assume a separable cost function $c(e, i) = c_e(e) + c_i(i)$. Then, for a given belief about effort, $\widehat{e}$, the following hold:*

i. If $v_\eta(i, \eta) = 0$, outside and inside activities are independent (i.e., e is not affected by outside activities)

ii. If $v_\eta(i, \eta) > 0$, the outside activity is a complement to the inside activity (i.e., the outside activity increases e)

[13] The results would also go through when $\eta_1 \neq \eta_2$, to the extent there is some persistence in the process that generates η_2. In other words, learning something about η_1 tells us something about η_2.

iii. If $v_{i\eta}(i,\eta) > 0$, e and i are strategic complements.

Proof. *Given the principal's belief about effort, $\widehat{e}$, the agent solves the following problem:*

$$\max_{e,i} \left\{ \begin{array}{c} w_1 - c_e(e) - c_i(i) + \delta E[p(e,\eta)] \cdot (w_2(\overline{y}) + \sigma \cdot E[v(i,\eta) \mid \widehat{e}, \overline{y}]) \\ +\delta(1 - E[p(e,\eta)]) \cdot \left(w_2\left(\underline{y}\right) + \sigma \cdot E\left[v(i,\eta) \mid \widehat{e}, \underline{y}\right]\right) \end{array} \right\} \tag{1'}$$

which yields the first order condition with respect to e:

$$\delta \cdot E_\eta\left[p'(e,\eta)\right] \cdot \left(\begin{array}{c} w_2(\overline{y}) + \sigma \cdot E_\eta[v(i^*,\eta) \mid \widehat{e}, y_1 = \overline{y}] - \\ -w_2\left(\underline{y}\right) - \sigma \cdot E_\eta\left[v(i^*,\eta) \mid \widehat{e}, y_1 = \underline{y}\right] \end{array} \right) = c_e'(e)$$

If $v_\eta(i,\eta) = 0$, outside activities do not depend on ability. Therefore, $v(i,\overline{\eta}) = v\left(i,\underline{\eta}\right)$, and we can simply write $v(i)$. The agent's objective function becomes: $w_1 - c(e,i) + \delta w_2\left(\underline{y}\right) + \delta\sigma \cdot v(i) + \delta E_\eta[p(e,\eta)] \cdot \left(w_2(\overline{y}) - w_2\left(\underline{y}\right)\right)$. It is immediate that the optimal e is independent of σ and i, since $c(e,i)$ is separable.

If $v_\eta(i,\eta) > 0$, then $E_\eta[v(i,\eta) \mid \widehat{e}, y_1 = \overline{y}] - E_\eta\left[v(i,\eta) \mid \widehat{e}, y_1 = \underline{y}\right] > 0$. This translates into an increased difference in the payoff after high and low output. Hence, increasing the incentives for e.

Finally, when $v_{i\eta}(i,\eta) > 0$ the strategic complementarity follows from the supermodularity of the agent's objective function (when $\sigma = 1$):

$$\frac{\partial U}{\partial e \partial i} = E_\eta\left[p'(e,\eta)\right] \cdot \frac{\partial}{\partial i}\left(E_\eta[v(i,\eta) \mid \widehat{e}, y_1 = \overline{y}] - E_\eta\left[v(i,\eta) \mid \widehat{e}, y_1 = \underline{y}\right]\right) > 0$$

since $E_\eta[p(e,\eta)]$ is increasing in e, and $E_\eta[v(i,\eta) \mid \widehat{e}, y_1 = \overline{y}] - E_\eta\left[v(i,\eta) \mid \widehat{e}, y_1 = \underline{y}\right] = \left(\mu^2(\widehat{e}) - \mu_2(\widehat{e})\right) \cdot \left(v(i,\overline{\eta}) - v\left(i,\underline{\eta}\right)\right)$ is increasing in i, by the complementarity of investment and ability. ■

This proposition expresses the main result of the paper. Namely, that 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). Moreover, if a larger investment in outside activities is more profitable for more able agents, both efforts become strategic complements. In other words, when e increases, there are better chances to gain a good reputation. This, in turn, provides more incentives to invest in outside activities. But that just further increases the return to acquire a good reputation, further increasing the incentives for e.

Given the optimal response of the agent to a certain belief of the principal, $e^*(\widehat{e},\sigma)$, an equilibrium

effort level is characterized by the equation $e = e^*(e, \sigma)$. Notice that without further assumptions, uniqueness of equilibrium is not guaranteed. We will focus only on the set of stable equilibria, denoted by $E^*(\sigma)$.[14] The maximum and minimum stable equilibrium effort levels are denoted $e^*(\sigma) = \max E^*(\sigma)$ and $e_*(\sigma) = \min E^*(\sigma)$, respectively. The equilibrium effort levels have the following property:

Proposition 3 *Suppose that $v_\eta(i, \eta) > 0$, and the cost function is separable. Then, the maximal and minimal stable equilibrium effort levels increase when outside activities are allowed, i.e., $e^*(\sigma = 1) > e^*(\sigma = 0)$ and $e_*(\sigma = 1) > e_*(\sigma = 0)$.*

Proof. *First, notice that for any belief $\widehat{e}$, the agent chooses a positive level of effort, $e^*(\widehat{e}, \sigma) > 0$, independently of whether the outside activity is allowed or not. This is true even when $\widehat{e} = 0$. Moreover, $e^*(\widehat{e}, \sigma)$ is bounded above. This can be seen from the agent's first order condition:*

$$\begin{aligned} c_e'(e) &= \frac{\partial E_\eta[p(e,\eta)]}{\partial e} \cdot \left(\begin{array}{c} w_2(\overline{y}) + \sigma \cdot E_\eta[v(i,\eta) \mid \widehat{e}, y_1 = \overline{y}] - \\ -w_2(\underline{y}) - \sigma \cdot E_\eta[v(i,\eta) \mid \widehat{e}, y_1 = \underline{y}] \end{array} \right) \\ &\leq \frac{\partial E_\eta[p(e,\eta)]}{\partial e} \cdot (\overline{y} + v(i, \overline{\eta})) \end{aligned}$$

The proposition then follows from the observation that the smallest stable equilibrium $e_*(\sigma)$ satisfies $e^*(e, \sigma) \geq e$ for any $e \leq e_*(\sigma)$, while the largest stable equilibrium $e^*(\sigma)$ must be such that $e^*(e, \sigma) \leq e$ for any $e \geq e^*(\sigma)$. From the previous proposition, we know that $e^*(e, \sigma = 1) > e^*(e, \sigma = 0)$ whenever $v_\eta(i, \eta) > 0$. Take the smallest stable equilibrium when no outside activity is allowed, $e_*(0)$. By the previous conditions it follows that $e^*(e, 1) > e^*(e, 0) \geq e$ for any $e \leq e_*(0)$. Hence, $e_*(1) > e_*(0)$. Similarly, for the largest stable equilibrium we have $e^*(e, 0) < e^*(e, 1) \leq e$ for any $e \geq e^*(\sigma)$. Hence, $e^*(0) < e^*(1)$. ■

There are a few observations that follow from this proposition. If there is a unique equilibrium (and hence the equilibrium must be stable) when no outside activities are allowed, then any stable equilibrium that emerges when they are must have a higher effort level. Similarly, if the equilibrium when outside activities are allowed is unique, it must involve an effort level that is higher than any stable equilibrium of the case without the outside activity. In any event, the increased incentives coming from the outside activity generate a higher equilibrium effort in public trade at no cost for the principal.

In the previous analysis we have assumed away the possibility of limited attention. However, the comparative statics would still remain unchanged when outside activities increase the cost of effort:

[14] The set of stable equilibria consists of those effort levels, e^*, such that $e^* = e^*(e^*, t)$, and $e^*(e, t) \geq e$ for $e \in (e^* - \epsilon, e^*]$ and $e^*(e, t) \leq e$ for $e \in [e^*, e^* + \epsilon)$, for some $\epsilon > 0$. Notice this set depends on whether the outside activity is allowed.

Proposition 4 *Assume there is limited attention, $c(e,i) = c(e+i)$, and outside activities provide value $v(i,\eta)+\kappa\phi(\eta)$ to the agent, with $\kappa \geq 0$ and $\phi(\eta)$ increasing. Then, for a given belief about effort, $\widehat{e}$, the agent's optimal response $e^*(\widehat{e}, \sigma = 1, \kappa)$ is increasing in κ. Therefore, there is a κ^* such that outside activities increase effort if and only if $\kappa \geq \kappa^*$.*

Proof. *See Appendix.* ■

When the agent has limited attention, the outside activity might reduce effort. However, the more the outside activity depends on ability, the higher the variability of the agent's second period payoff as a function of first period output. This induces higher incentives, and hence makes it more desirable to allow it.

3.3 Non-observable Output

The non-verifiability of output creates a problem for the transmission of information to the market when outsiders cannot observe the first period output. Without any information, they would have to expect an average ability level from the agent. In principle, then, when outsiders do not observe output they cannot adjust their compensation (on outside activities) to the new information generated. Moreover, this information asymmetry translates into a de facto departure from perfect competition. Layoffs, however, provide a mechanism to transfer (at least partially) that information to the markets when they are correlated with first period output.

We show here how terminations can occur in the model. This will allow us to extend the results in the previous section to the case where outsiders are uninformed about first period performance.

Two polar cases are considered here. First, the initial contract cannot be renegotiated ex-post (after the realization of the first period output).[15] Alternatively, principal and agent might not be able to commit not to renegotiate when mutually beneficial. In the latter case, the principal will be assumed to have all the bargaining power.

The following result states that, in general, it is not an equilibrium for the market to learn nothing about ability in either of the two cases.

Lemma 5 *Suppose that a fraction $\phi > 0$ (small) of agents leave the principal for exogenous reasons. Then, there is no equilibrium in which no dismissal takes place (i.e., the agent gets laid-off after the*

[15] The extreme communication difficulties faced by the East India Company certainly made any potential renegotiation of the contract prohibitively costly. This case might be best suited for this particular example.

first period with positive probability).[16]

Proof. *Suppose the agent never gets dismissed. Then, whenever an agent leaves the principal, the market will believe it is for exogenous reasons, and will assume an average level of ability. Similarly, when the agent stays with the principal for a second period, the market learns nothing about ability. Hence, the market wage in the second period for someone leaving the principal will be* $\overline{w}_2 = E_\eta [y_2]$*, and output from outside activities will be* $E_\eta [v(i,\eta)]$*. However, if the agent stays inside, output is expected to be* $E_\eta \left[y_2 \mid \underline{y}\right] < E_\eta [y_2]$*, and outside activities would still pay* $E_\eta [v(i,\eta)]$*. It is easy to see the principal would not be willing to match the offer from the outside market, and termination will occur.* ■

The result follows from the observation that when nobody is dismissed and no information is revealed to the market, the principal will value less a failed agent than outsiders would.

Since some degree of information still goes to the market, a similar result to proposition 2 holds also in both these cases. They are, then, robust to the alternative information setting where outsiders do not observe internal performance.

Proposition 6 *Assume a separable cost function* $c(e,i) = c_e(e) + c_i(i)$*. Then for a fixed wage* w_2 *and belief about effort,* $\widehat{e}$*, the following hold:*

i. If $v_\eta(i,\eta) = 0$*, outside and inside activities are independent (i.e.,* e *is not affected by outside activities)*

ii. If $v_\eta(i,\eta) > 0$*, the outside activity is a complement to the inside activity (i.e., the outside activity increases* e*)*

iii. If no renegotiation can take place, and $v_{i\eta}(i,\eta) > 0$*, then* e *and* i *are strategic complements.*

Proof. *See Appendix.* ■

When no renegotiation is possible, the principal will decide to dismiss the agent whenever $w_2 > E[y_2 \mid y_1]$, independently of what happens with the outside activity. When a fraction of agents leaves for exogenous reasons, the outside market will always offer a wage larger than $E[y_2 \mid y_1]$. As a result, the previous condition will always be satisfied (otherwise all agents would leave for the outside market),

[16] *If we assume the principal can hire another agent in the second period from the outside market, the same result would go through even when markets are not prefectly competitive. To see this, let* $\overline{w}_2$ *be the market wage when nobody gets dismissed in the first period, and the markets learn nothing about first period performance. Then, if the agent leaves, she gets* $\overline{w}_2 (+E_\eta [v(i,\eta)])$*, and the principal would hire another agent, making a profit of* $E_\eta [y_2] - \overline{w}_2$*. Total surplus is then the same as for the competitive case. Hence, termination is optimal, as shown in the proof.*

and the agent is dismissed with probability one after a bad realization. However, when renegotiation can take place, the agent is willing to accept a reduction in the wage after a low output. When she remains for a second period, she pools with those agents that obtained a high output. Her reputation then is enhanced with respect to those who are forced to leave. From the previous lemma, though, not all agents that obtain a low output can successfully renegotiate. When an agent that obtains a low output is laid-off in equilibrium with probability one, this case is equivalent to the no renegotiation one. Therefore, all three points of the proposition are true. When that probability, denoted α, is less than one part (iii) of the proposition no longer holds, even though the outside activity still increases effort inside. The reason being that an increase in i makes ability more productive. This, in turn increases the incentives to renegotiate and a lower fraction of agents get dismissed. The outside market then learns less about ability, reducing the variability of compensation for outside activities. In the appendix we show that the increased dependence of outside activities on ability is completely offset by the loss of information to the market. In this case, an increase in i has no effect on the incentives for effort e.

Incentives for effort are increasing in the difference between payoff following high and low output. That difference is equal to $w_2 + E_\eta [v(i,\eta) \mid \alpha, in] - E_\eta [y_2 \mid \alpha, out] - E_\eta [v(i,\eta) \mid \alpha, out]$, which is decreasing in the probability of dismissal, since $E_\eta [v(i,\eta) \mid \alpha, in]$ is decreasing in α, while $E_\eta [y_2 \mid \alpha, out] + E_\eta [v(i,\eta) \mid \alpha, out]$ is increasing in α. Moreover, since there are more dismissals when no renegotiation can take place, the incentive effects of outside activities get reduced when renegotiation occurs. Dismissals provide a mechanism to transfer information to the outsiders about ability. However, this mechanism becomes less powerful when the principal can renegotiate the contract and offer a lower wage to the agent when ability is realized to be low. The agent would be willing to accept, since remaining for a second period would "fool" outsiders into thinking that her ability is higher.[17] As a consequence, less layoffs occur. This translates into lower information to the market, and hence less variability in the compensation from the outside activity. Despite this, though, still some information flows to outsiders, improving incentives relative to the case with no outside activity.

As in the observable case, effort is still increased in equilibrium with the outside activity:

Proposition 7 *Suppose that $v_\eta(i,\eta) > 0$, and the cost function is separable. Then, the maximal and minimal stable equilibrium effort levels increase when outside activities are allowed, i.e., $e^*(w_2, \sigma = 1) > e^*(w_2, \sigma = 0)$ and $e_*(w_2, \sigma = 1) > e_*(w_2, \sigma = 0)$. Hence, it is optimal to allow such activity.*

[17] In equilibrium, the market is not fooled. However, when the agent realizes a low output in the first period, and successfully renegotiates to remain in the company, she is able to pool with those agents that obtained a high output. Market expectations about ability are then higher than those of the principal and agent (who possess more information).

Proof. *If follows from the same argument in the proof of proposition 3.* ■

For a fixed second period wage, the agent is willing to put more effort when outside activities are allowed. By doing so, she increases the chances she obtains a high output, and remains working for the principal in the second period. On the contrary, if output is low she will be dismissed with some probability. The market then learns that following dismissal, the expected ability decreases. Therefore, gaining a good reputation with the principal has spill-over effects on outside activities. That, in turn, increases incentives with respect to the case where no outside activity is allowed. Or in other words, when outside activities are allowed it becomes cheaper (or rather, it requires a lower second period wage) to implement any effort level.

3.4 The Effort Model

In the previous sections we developed the basic arguments with a model where outside activities required an investment in the first period that paid-off in the second. This effectively ruled out the possibility of learning about ability from the output on the outside activity. We deal with this possibility here by analyzing a model where the outside activity is of a more similar nature as the inside activity (requiring to put effort every period, rather than investing). This will show the previous conclusions are not specific to the particular assumptions of the model, and can generalize to this framework under certain conditions.

As before, there are two periods[18], in which ability takes the same value ($\eta_1 = \eta_2$). Output from both activities will be non-verifiable, but observable to the principal, agent, and outside market. However, to ease the exposition we depart from the previous framework by assuming that output takes the linear form $y_t = e_t + \eta + \varepsilon_t$, with ε_t being noise. As in Holmstrom (1982), ε_t is normally distributed, $\varepsilon_t \sim N\left(0, \sigma_\varepsilon^2\right)$. And so it is the prior distribution of ability, $\eta \sim N\left(\overline{\eta}, \sigma_\eta^2\right)$. Outside activities will pay off $v_t = i_t + \gamma\left(\eta_t + \xi_t\right)$, with $\xi_t \sim N\left(0, \sigma_\xi^2\right)$ and $\gamma \geq 0$.[19] All random variables, η, ε_t, and ξ_t are independent. As a final piece of notation, let h_r represent the precision (the inverse of the variance) of the random variable r. δ is the discount factor. We will also assume a separable cost function. Later we will discuss how the results change when limited attention is introduced.

[18] All the results in this section extend to the steady state equilibrium of the model with an infinite number of periods a la Holmstrom (1982).

[19] By assuming that the parameter γ multiplies both η_t and ε_t', we make the signal to noise ration independent of γ. This will turn out to be useful for separating the effects of a higher productivity of ability, and a better signal to noise ratio when doing comparative statics.

We start first by looking at the case where outside activities are not allowed. This corresponds to Holmstrom's career concerns model. m_2 represents the updated beliefs about ability at the end of period 1: $m_2 = E[\eta \mid y_1]$. The updating process takes the following form:

$$m_2 = \alpha\overline{\eta} + (1-\alpha)(y_1 - \widehat{e}_1), \text{ where } \alpha = \frac{h_\eta}{h_\eta + h_\varepsilon}$$

$\widehat{e}_1$ represents the conjecture of the principal about the agent's effort level.

Since second period effort is nil, m_2 will also be the expected output, and hence the wage the agent receives. First period effort will affect that wage through an increase in first period output (which in turn increases the expectation of ability m_2). She then maximizes:

$$\max_{e,i} \{w_1 - c_e(e) + \delta m_2(e)\}$$

which yields the first order condition:

$$\delta(1-\alpha) = c_e'(e)$$

To compare the equilibrium with the case with outside activities, we will denote these variables by $\alpha^*(\sigma = 0)$ and $e^*(\sigma = 0)$. From this, it is easy to derive the following comparative static:

Lemma 8 $(1 - \alpha^*(\sigma = 0))$ *and* $e^*(\sigma = 0)$ *are increasing in* h_ε *and decreasing in* h_η.

We now turn to study the case where both activities are allowed. In this case, 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:

$$\begin{aligned} z_1 &= E[\eta \mid y_1, v_1] = \frac{h_\varepsilon(y_1 - e_t) + h_\xi\left(\frac{v_1 - i_t}{\gamma}\right)}{h_\varepsilon + h_\xi} \\ Var(z_t) &= \frac{1}{h_\varepsilon + h_\xi} \end{aligned}$$

And the updating process becomes:

$$\begin{aligned} m_2 &= \alpha\overline{\eta} + (1-\alpha) z_1 = \frac{h_\eta\overline{\eta} + h_\varepsilon(y_1 - \widehat{e}_1) + h_\xi\left(\frac{v_1 - \widehat{i}_1}{\gamma}\right)}{h_\eta + h_\varepsilon + h_\xi} \\ \alpha &= \frac{h_\eta}{h_\eta + h_\varepsilon + h_\xi} \end{aligned}$$

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

The first order conditions that determine effort in the inside activity and investment in private trade now become:

$$\begin{aligned}(1+\gamma)\left(\delta(1-\alpha)\frac{h_\varepsilon}{h_\varepsilon+h_\xi}\right) &= c_e'(e)\\ \left(\frac{1+\gamma}{\gamma}\right)\left(\delta(1-\alpha)\frac{h_\xi}{h_\varepsilon+h_\xi}\right) &= c_i'(i)\end{aligned}$$

Hence, we get the following result:

Proposition 9 *Assume a separable cost function. Then, $e^*(\sigma=1)\geq e^*(\sigma=0)$ if and only if $\gamma(h_\eta+h_\varepsilon)\geq h_\xi$.*

Proof. *Since the cost function is separable, we only need to find the condition for the returns to e to be higher with outside activities. That is: $(1+\gamma)\left(\delta(1-\alpha(\sigma=1))\frac{h_\varepsilon}{h_\varepsilon+h_\xi}\right)=(1+\gamma)\left(\delta\frac{h_\varepsilon}{h_\eta+h_\varepsilon+h_\xi}\right)\geq \delta(1-\alpha(\sigma=0))=\delta\frac{h_\varepsilon}{h_\eta+h_\varepsilon}$. It is immediate to see this is satisfied when $\gamma(h_\eta+h_\varepsilon)\geq h_\xi$.* ■

This result shows that under certain conditions, outside activities increase effort inside also in this framework. However, this case opens the possibility for outside activities crowding out effort, even when the cost of effort is not increased by the larger number of tasks. The reason being that output from the extra activity provides a further signal about ability, and hence less weight is put on output produced inside during the updating process. Effort e, then, does not have as high an impact on the perception of ability. The positive effect remains the same as before: the extra activity provides more opportunities for profiting from a reputation for high ability. Whenever outside activities provide a lousy signal about ability (low precision h_ξ), or are greatly affected by ability (high γ), outside activities increase incentives for effort e.

Finally, we introduce limited attention in the model. The first order conditions when the cost function takes the form $c(e,i)=c(e+i)$ become:

$$\begin{aligned}(1+\gamma)\left(\delta(1-\alpha)\frac{h_\varepsilon}{h_\varepsilon+h_\xi}\right) &\leq c'(e+i) \text{ with } e^*=0 \text{ if inequality strict}\\ \left(\frac{1+\gamma}{\gamma}\right)\left(\delta(1-\alpha)\frac{h_\xi}{h_\varepsilon+h_\xi}\right) &\leq c'(e+i) \text{ with } i^*=0 \text{ if inequality strict}\end{aligned}$$

Form this it is immediate to see that, because of the constant returns to scale technology, the agent

will only put effort in the most productive activity[20]. The condition that guarantees that $e^* > 0$ is $\gamma h_\varepsilon > h_\xi$. When this is satisfied, $i^* = 0$ and e^* satisfies $(1+\gamma)\left(\delta(1-\alpha)\frac{h_\varepsilon}{h_\varepsilon+h_\xi}\right) \leq c'(e)$. Moreover, the condition $\gamma h_\varepsilon > h_\xi$ is stronger than that for the separable case, $\gamma(h_\eta + h_\varepsilon) \geq h_\xi$. Therefore, we obtain:

Proposition 10 *Assume $c(e,i) = c(e+i)$. Then, $e^*(\sigma=1) \geq e^*(\sigma=0)$ if and only if $\gamma h_\varepsilon \geq h_\xi$.*

The outside activity might still be beneficial for incentives. However, since limited attention introduces yet an additional negative effect, the condition required is stronger.

The previous results arise from the linearity of the production function. Even though this yields knife-edge results, the conclusions are robust to less extreme cases. To see this, consider the case where outputs take the form $y_t = f(e_t) + \eta_t + \varepsilon_t$ and $v_t = g(i_t) + \gamma(\eta_t + \xi_t)$, with $f(\cdot)$ and $g(\cdot)$ being concave functions with $f'(0) = g'(0) = +\infty$. This guarantees an interior solution to the agent's problem. The first order conditions now become:

$$\begin{aligned}(1+\gamma)\left(\delta(1-\alpha)\frac{h_\varepsilon}{h_\varepsilon+h_\xi}\right)f'(e) &= c'(e+i)\\ \left(\frac{1+\gamma}{\gamma}\right)\left(\delta(1-\alpha)\frac{h_\xi}{h_\varepsilon+h_\xi}\right)g'(i) &= c'(e+i)\end{aligned}$$

The following result makes clear the same intuition of the linear case still goes through here:

Proposition 11 *$e^*(\sigma=1)$ is increasing in h_ε and γ. $i^*(\sigma=1)$ is decreasing in γ, and increasing in h_ξ.*

If outside activities do not reveal too much information about ability (they have low precision), or if outside activities depend on ability to a great extent (γ large) then they increase effort in the inside activity. When h_ξ is small, outside activities are not a very useful measure of ability.[21] Therefore they receive little weight in the updating process, reducing the incentives for i. Also, when γ is high, effort in outside activities has a small effect on the update of beliefs ($1/\gamma$). This translates into an increase in total wages next period on the order of $\left(\frac{1+\gamma}{\gamma}\right)$, whereas effort in inside activities obtain a return proportional to $(1+\gamma)$.

[20] When both activities are equally productive, the agent in indifferent about the allocation of effort between the two tasks. Only total effort is uniquely determined.

[21] This is not to say that ability is unimportant for outside activities, since that is determined by the parameter γ.

4 Discussion

In this section we discuss the evidence on the East India Company, and other examples, in light of the previous theoretical discussion.

4.1 East India Company Case

The theoretical discussion presented above emphasizes the importance of synergies between public and private trade as a determinant of the desirability of allowing the latter to take place. When those synergies are important, the benefits they generate may overcome the potential costs arising from the conflict of interest emphasized by Holmstrom and Milgrom.

The complementarities between public and private trade captured by our model were indeed at work in the East India Company. The similarities between the two activities (both require the mastering of trading skills) certainly played a role in explaining the job design that was implemented.

Starting in 1757 with the battle of Plassey, though, the Company started to gain strong political power in Bengal. This culminated in 1965, when the Company won the title of Diwan of Bengal, for which it could administer the finances, taxation, and civil justice. In other words, the Company became the local governor of Bengal. From that point on, the trading divisions of the Company began to loose weight in the organization in favor of the new administrative tasks. The comparison of the incentive schemes in both divisions deserves some attention. While traders continued a similar incentive scheme as the one discussed here (even though base salaries were greatly increased, in a response to a decline in the profitability of private trade), the agents in charge of the administrative division were not allowed to trade on their own accounts. This could be explained by a lack of synergies between the activities that involve trading and tax collection. In that case, the negative externalities highlighted by Holmstrom and Milgrom come to play a more crucial role.

4.2 The Hudson's Bay Company

A contemporaneous experience offers yet another example in line with the theory presented in the previous section. Charlos and Nicholas (1990) describe the agency problems within the Hudson's Bay Company.[22] This company also explored with the incentive scheme of its traders. Initially they were allowed to hunt their own furs, and sell them in England, with the rest of the company's furs. However, they later found this increased the possibilities for opportunism of the agents (in the form of swaps of

[22] The Hudson's Bay Company had the monopoly of the fur trade between England and the Hudson's Bay, in Canada.

their furs for the company's higher quality furs, or simply theft). There was, however, no clear benefit from those activities (besides the additional rents provided to the agents). As a result came a total prohibition of these outside activities. But together with it, an increase in the salary (to compensate for the loss of rent). Clearly the absence of synergies between public and private activities determined the final organizational structure.

4.3 Contemporary Cases

Our model resonants with more contemporary employment relations as well. Some professionals today are indeed in positions which involve a relatively flat wage structure and at the same time permit outside activity. The availability of outside options encourages greater effort in public activities which may in turn lead to greater outside rewards. In US higher education, for example, a professor's salary increases with her rank which remains constant over many years. Yet she typically has scope to engage in remunerative outside activities such as sponsored research, consulting, public speaking, and other projects related to her field of expertise. Success in her employer-centered tasks, for example a solid record of scholarly achievement, signals high ability and may have a corresponding positive impact on her private, non-university, options. Universities are understandably interested in how a faculty member allocates her effort across different activities. As the American Association of University Professors (AAUP) acknowledges, at the root of this concern is the problem of monitoring. In their *Policy Documents and Reports*, widely considered the authoritative source on sound academic practice, the Association writes, "A system of precise time accounting is incompatible with the inherent character of the work of faculty members, since the various functions that they perform are closely interrelated and do not conform to any meaningful division of a standard workweek. On the other hand if the [outside work agreement] contemplates that a faculty member will devote a certain fraction of effort to the [outside activity]... a demonstrable relationship between the indicated effort or responsibility and the actual extent of the faculty member's involvement is to be expected" (2001, p.145).

To that end, universities include in faculty handbooks 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 faculty participation in outside activities. Others insist that a share of external grants received go to the university. Such policies testify to the university's concern that non-university activities may place competing demands on a faculty member's attention. More importantly, however, the wide flexibility in interpreting and enforcing such guidelines indicate that inside and outside activities can quite plausibly reinforce one another. Serving as an expert witness on a price-

fixing case, for example, may serve one's research agenda. And conversely, acquiring the expertise on such topics through extensive research certainly increases the prospects for such outside activities. These experiences will very likely enrich classroom teaching as well. Universities are cognizant of such synergies and faculty members retain significant latitude in their choice of private activities.

Another example comes from professional sports. Signers of multiyear contracts, many professional athletes can face fixed salaries over long stretches of their short careers. Athletes have started restaurant chains, starred in motion pictures, written autobiographies and pursued numerous activities while being active players. Being a star athlete has obvious positive externalities for private trade. The reverse may also be true. Starring in a movie may not have improved Shaquille O'Neal's on court play. However it may have boosted ticket sales and name recognition for the team, benefits accruing to the team owner.

5 Conclusions

Our theoretical investigation of the job design problem was motivated by internal organization of the English East India Company. In this manner we continue the conversations between economic theorists and business historians that began with Oliver Williamson's distinguished advances (1975, 1985) in transactions cost economics and Alfred Chandler's landmark work (1977, 1990) on the rise of the modern industrial enterprise (Lamoreaux and Raff, 3). Theorists have looked to the rich institutional detail provided by business history for inspiration in advancing new frontiers in economic modeling and for potential data settings with which to test their theories (Milgrom and Roberts, 1992). Historians have in turn found the insights of economic theory an enriching framework for their narratives (Temin, 1991, Lamoreaux and Raff, 1994). The East India Company case provided new evidence inconsistent with the principle that states that "(financial) responsibility and authority should go hand in hand" (Holmstrom and Milgrom 1991, p. 41). Our model offers a new approach that reconciles a broad range of evidence from historical and modern accounts with the current understanding of job design.

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6 Appendix: proofs

Proof (Proposition 4). Lets $U(e,i,\kappa)$ be the objective function of the agent as a function of (e,i,κ). Consider the change of variables $(e,i,\kappa) \to (e,s,\kappa)$, where $s = e+i$. Then, the transformed function $\widetilde{U}(e,s,\kappa) = U(e,s-e,\kappa)$ is supermodular in (e,s,κ), since

$$\begin{aligned}
\frac{\partial^2 \widetilde{U}}{\partial e \partial \kappa} &= E_\eta\left[p'(e,\eta)\right] \cdot \left(E_\eta\left[\phi(\eta) \mid \widehat{e}, y_1 = \overline{y}\right] - E_\eta\left[\phi(\eta) \mid \widehat{e}, y_1 = \underline{y}\right]\right) > 0 \\
\frac{\partial^2 \widetilde{U}}{\partial s \partial \kappa} &= 0 \\
\frac{\partial^2 \widetilde{U}}{\partial e \partial s} &= \delta \left[\begin{array}{c} E_\eta\left[p'(e,\eta)\right] \cdot \left(E_\eta\left[v'(s-e,\eta) \mid \widehat{e}, y_1 = \overline{y}\right] - E_\eta\left[v'(s-e,\eta) \mid \widehat{e}, y_1 = \underline{y}\right]\right) - \\ -(1-p(e,\eta)) \cdot E_\eta\left[v''(s-e,\eta) \mid \widehat{e}, y_1 = \underline{y}\right] - \\ -p(e,\eta) \cdot E_\eta\left[v''(s-e,\eta) \mid \widehat{e}, y_1 = \overline{y}\right] \end{array} \right] \geq 0
\end{aligned}$$

It follows from the supermodularity of $\widetilde{U}$ that e^* and s^* are both increasing in κ. The last part of the proposition is immediate from this. ■

Proof (Proposition 6). First notice that it is never optimal to terminate the relationship after $y_1 = \overline{y}$ (unless for exogenous reasons). The proof, now, considers two cases. First we deal with the case where no renegotiation can take place after the first period output is observed. Then we relax this, allowing for such renegotiation after the first period.

Assume that no renegotiation can take place. We have already seen that there is always some probability of termination after the low output is realized. Denote by $\alpha(w_2) \in (0,1]$ such probability, as a function of the second period wage. (Note this probability is independent of whether the outside activity is allowed.) If $w_2 > E\left[y_2 \mid \underline{y}\right]$, then it must be that $\alpha(w_2) = 1$ (the principal would make negative profits from keeping the agent). Otherwise, $\alpha(w_2) \in (0,1)$. Under such conditions, the agent would obtain $E_\eta\left[v(i,\eta) \mid \alpha(w_2), in\right]$ from the outside activity if she stays in the company, and $E_\eta\left[v(i,\eta) \mid \alpha(w_2), out\right]$ if she leaves. It is clear that $E_\eta\left[v(i,\eta) \mid \alpha(w_2), in\right] > E_\eta\left[v(i,\eta) \mid \alpha(w_2), out\right]$, since $\alpha(w_2) > 0$ (outsiders manage to learn from the employment status of the agent). Hence, outside activities provide additional incentives for the acquisition of a reputation, and all the results go through.

Assume, now, that principal and agent can renegotiate after the first period. The agent would still be fired with positive probability after a bad realization. Denote the new probability by $\widetilde{\alpha}(w_2,\sigma) \in (0,1]$. w_2 will represent the wage contracted ex-ante, and w_2^R the renegotiated wage. When no outside activity is allowed, the agent is always dismissed after a bad realization (just as before), and $\widetilde{\alpha}(w_2,\sigma=0) = 1$. Effectively, no renegotiation takes place. When outside activities are allowed, the agent is willing to pay

(accepting a wage below the market wage) to remain for the second period, and signal high ability, as long as $v_\eta(i,\eta) > 0$.[23] Since there is a positive probability of no continuation, the principal must be making non-positive profits: $w_2^R \geq E_\eta\left[y_2 \mid \underline{y}\right]$. If $\widetilde{\alpha}(w_2, \sigma = 1) = 1$, then we are back in the no renegotiation case. Lets consider, then, the more interesting case of $\widetilde{\alpha}(w_2, \sigma = 1) \in (0,1)$. Now, both principal and agent must be indifferent between producing for a second period, or not. Hence, $w_2^R = E_\eta\left[y_2 \mid \underline{y}\right]$ and $w_2^R + E_\eta\left[v(i,\eta) \mid \widetilde{\alpha}, in\right] = E_\eta\left[y_2 \mid \widetilde{\alpha}, out\right] + E_\eta\left[v(i,\eta) \mid \widetilde{\alpha}, out\right]$. This equation defines $\widetilde{\alpha}(w_2, \sigma = 1)$. Total incentives for effort come from the difference between the payoff after high and low output. When no outside activities are allowed, this difference is $w_2 - E_\eta\left[y_2 \mid \alpha, out\right]$. When outside activities are allowed, though, this difference becomes $w_2 + E_\eta\left[v(i,\eta) \mid \widetilde{\alpha}, in\right] - w_2^R - E_\eta\left[v(i,\eta) \mid \widetilde{\alpha}, in\right] = w_2 - E_\eta\left[y_2 \mid \underline{y}\right]$. It is immediate to see that the latter is larger than the former. Hence, incentives are increased. ■

[23] Otherwise, the payoff from the outside activity is constant, and the agent will always be dismissed after a bad realization. Hence, the outside activity would not increase the incentives for effort.