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**Working Paper**

## Career concerns and optimal disclosure policy

CSIO Working Paper, No. 0073

**Provided in Cooperation with:**

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*Suggested Citation:* Mukherjee, Arijit (2005) : Career concerns and optimal disclosure policy, CSIO Working Paper, No. 0073, Northwestern University, Center for the Study of Industrial Organization (CSIO), Evanston, IL

This Version is available at:

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THE CENTER FOR THE STUDY  
OF INDUSTRIAL ORGANIZATION  
AT NORTHWESTERN UNIVERSITY

Working Paper #0073

Career Concerns and Optimal Disclosure  
Policy<sup>†</sup>

By

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This Draft: October 27, 2005

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<sup>†</sup> This paper is based on Chapter 1 of my Ph.D. dissertation (2005) in Northwestern University. I would like to thank Michael Whinston for his invaluable guidance and support throughout this project. I am also indebted to Alessandro Pavan for his extremely helpful suggestions. I have greatly benefited from numerous discussions with Scott Schaefer and Dale Mortensen. For their helpful comments, I would like to thank Maria Goltsman, Piotr Kuszewski, Espen Moen, Eugene Orlov, Marcin Peski, Scott Stern, Michael Waldman, Jan Zájbojník, Fan Zhang, and seminar participants in Cornell, Northwestern, and Rutgers University, and Fall 2004 Midwest International Economics and Economic Theory Meeting, St. Louis. All the errors that remain are mine.

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## **Abstract**

Sequential contracting with multiple employers is a common feature of modern labor markets. Employment relations often terminate due to raids. When a worker is raided, the initial employer may enjoy an informational advantage over the raiders, as she is likely to have better information on the quality of her worker. If the worker has career concerns, and matching between firms and workers is important, the initial employer can strategically disclose this information to influence the worker's current incentives and matching efficiency. I show that, if the initial employer can use long-term complete contracts where she can commit to a second-period wage and severance payment, perfect competition in the raider market will ensure full information disclosure. In contrast, an optimal short-term contract induces full disclosure if i) the worker is risk neutral, ii) the worker does not face any liquidity constraints, and iii) the raider market is perfectly competitive. A partial converse of these results is also provided. By relaxing any of the above conditions, one can find situations where full disclosure is no longer optimal.

## 1. INTRODUCTION

Sequential contracting with multiple principals is a common feature of modern labor markets. Indeed, in United States, job-to-job flow constitutes a substantial proportion of total job separations. Farber (1999) shows evidence from Current Population Survey data that “over 28% of the workforce reports having been on their job for 1 year or less over the 1973-1993 period.” According to Fallick and Fleischman (2004), “on average 2.6% of employed persons change employers each month, a flow twice as large as that from employment to unemployment.”

Employment relations often terminate due to raids (or poaching), in which a raiding firm tries to bid away workers from other firms. Autor (2001) reports that “between 11 and 18% of Temporary Help Service workers placed on assignment in a calendar month are directly hired by clients.” However, when hiring an experienced worker (agent), a raiding firm (downstream principal) may face an informational disadvantage compared to the initial employer (upstream principal).<sup>1</sup> In fact, the latter typically possesses better information about the productivity (or type) of the agent as a result of having observed the agent’s past performance. In such an environment, the downstream principal’s offer will be based on her “beliefs” about the agent’s type. This offer affects not only the worker but also the upstream principal. Indeed, the wage in the upstream relationship may incorporate the surplus the agent expects from downstream relationships. As shown in Calzolari and Pavan (2004), upstream principals who anticipate their agents contracting also with downstream principals have strong incentives to commit up front to a disclosure policy that specifies what information will be disclosed to rival firms.

Strategic information disclosure is particularly relevant when the agent has career concerns and matching between firms and workers is important. In the presence of career concerns, the agent’s past performance influences his future wage. Thus, disclosure of information about the agent’s performance may sharpen his current incentives. It also affects the matching efficiency between workers and future employers. At the same time, more disclosure exposes the agent to human capital risk, as his future wages will fluctuate more with his current performance. Hence, an optimal disclosure policy trades off the benefits from sharper incentives and efficient matching with the cost of human capital risk.

The purpose of this paper is to formalize this trade-off and derive implications for the design of optimal disclosure policies.

I consider a two-period model where an upstream firm employs an agent whose ability is unknown to all parties. The agent works under an explicit pay-per-performance contract. At the end of the first period, the firm discloses information about the agent’s performance to potential future employers. In the second period, the agent may be raided (or “poached”) by rival firms where he is likely to be more productive (i.e., a better match). The initial employer then decides whether to match the best offer from the raiders or let the agent leave.

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<sup>1</sup>In what follows, I adopt the convention of referring to the agent (he) as the worker and the principal (she) as the firm.

I assume that the initial employer can credibly commit to an information transmission mechanism (henceforth referred to as a “disclosure policy”), which maps the worker’s performance measure into signals disclosed to other employers.

My first result shows that, if the initial employer can use a long-term complete contract, that is, if she can commit to a second-period wage and severance payment (or “bond” payment), her optimal contract will always induce full information disclosure under perfect competition in the raider market.<sup>2</sup>

The intuition behind this result is the following. As the agent is more productive with the raiders, trade efficiency requires turnover for all agent types. With partial disclosure, the firm holds better information than the raiders about the type of the agent. Accordingly, the firm will match the raiders’ best offer from the raiders only if she finds it worthwhile to do so, given her possession of superior information. Hence, a successful raid may imply that the agent is of low ability. This leads to a potential adverse selection problem. In response, the raiders may reduce their bids to limit the “winner’s curse” effect, which is similar to what occurs in common value auctions.<sup>3</sup> Full disclosure ensures a maximum possible trading surplus in the raiding game by eliminating the winner’s curse effect. Therefore, all types of agents leave for the raiding firm. As the raider market is perfectly competitive, the raiders necessarily earn zero profit and the agent is offered the entire matching gain. The firm can, in turn, extract this gain up front by reducing the wage paid to the worker in the first-period.

However, full disclosure may come at the cost of exposing the agent to a greater human capital risk by making future wages more sensitive to his current performance. If the agent is risk averse, the firm may need to pay a higher risk premium to make the agent willing to accept the contract. This additional premium, in principle, may outweigh the additional gains from trade that are derived from full disclosure. However, this is not the case when the firm can offer long-term complete contracts. Indeed, by adjusting the second-period wage and severance payment, the firm can guarantee that the agent’s payoff in every state of the world remains exactly the same as in the absence of full disclosure. By doing so, the firm insures the agent from the additional human capital risk and, hence, eliminates any need for an additional risk premium.

In some cases, however, long-term contracts may not be feasible. I define a short-term performance contract as a special case of long-term complete contract, in which the firm has no commitment power over the second-period wage and severance payment and offers a deterministic first-period wage for every output realization. My second result shows that, when the raider market is perfectly competitive, the optimal short-term performance contract induces full disclosure if i) the agent is risk neutral, and ii) he does not face any liquidity constraints.

The intuition for this result is simple. When the agent is risk neutral, the firm does not need to pay any risk premium for the human capital risk induced by disclosure. This, in

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<sup>2</sup>A severance payment is a transfer payment by the firm to its employee upon termination of employment.

<sup>3</sup>See McAfee and McMillan (1987).

principle, suggests that the impossibility of writing long-term contracts has no impact under risk neutrality. However, the impossibility of committing to future wages and severance payments also implies that the initial employer cannot charge the agent in period-two for the additional surplus he obtains by leaving the firm. Hence, the only way the firm can appropriate the efficiency gain associated with full disclosure is by reducing the agent's wage in the first-period. This, however, may require a negative wage payment from the firm to the worker, a payment sustainable only if the agent faces no liquidity constraints. In contrast, when the parties can commit to a long-term complete contract, there is no need to make the agent pay up front for the surplus he expects in the downstream relationship. The firm can simply use the severance payment to appropriate, in period-two, at least part of the wage the worker receives from his new employers.

The two results discussed above serve as a benchmark for the optimality of full disclosure. A partial converse is also true. If any of the conditions in these results is violated, one can find preferences for the agent and parameter values for which full disclosure is no longer optimal. In this sense, the above conditions are not only sufficient but also “almost” necessary for the optimality of full disclosure.

To investigate the role of each of these conditions, I relax them one at a time. First, consider the assumption of perfect competition in the raider market. Suppose, in contrast, that there is only a monopsonistic raider. In that case, under full disclosure, the raider appropriates the entire efficiency gain of transferring the agent to her firm. On the other hand, by pooling low-ability workers with those of high ability, the initial employer can sell a “lemon” at the price of a “plum” and, hence, earn profit. The initial employer may then find it optimal to commit to a policy that discloses only noisy information regarding the agent's past performance.<sup>4</sup>

Next, assume that the firm cannot offer long-term contracts and that the “no liquidity constraint” assumption is violated, so that the firm may not be able to make the agent pay up front in return for a higher wage later in his career. To understand why the firm may resort to partial disclosure, suppose that, with full disclosure, career concern incentives are so strong that the worker exerts effort even if his wage in period-one is fixed at zero. By switching from full to partial disclosure, the upstream principal can still preserve enough career concerns to make the agent work for free and, at the same time, by partially pooling the two types of workers together, retain some of the high-ability workers at the price of those of low ability in period-two. This way, the firm earns extra profits.

Finally, consider the role of risk neutrality in the context of short-term performance contracts. When the agent is risk averse, the firm has to pay an additional risk premium in case she commits to full disclosure, since full transparency means high sensitivity of future wages to current performance. This risk premium might outweigh the efficiency gains from allowing the agent to leave at the market wage under full disclosure. It follows that, when the agent's risk aversion is high, the upstream principal may find it optimal to sacrifice future efficiency

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<sup>4</sup>A similar result is obtained by Calzolari and Pavan (2004).

for a lower risk premium. This is obtained by committing to a policy that reveals only a noisy signal of the agent's past performance.

As discussed in Calzolari and Pavan (2004), the disclosure mechanism is modeled as a signaling mechanism that generates signals according to a pre-specified probability distribution conditional on the worker's performance. Though this may seem rather abstract, such a mechanism captures quite a few real life examples of disclosure policies. For instance, publicly announced promotions can be thought of as signals of a worker's quality to outsiders (Waldman, 1984). Job design can also be thought of as a signaling mechanism. The firm can design jobs in such a way that she makes the worker's quality visible to outsiders with an appropriate degree of noise. Loveman and O'Connell (1996) provide a case study of a Silicon-Valley firm, HCL America. They argue that retention of software developers is one of the biggest challenges for the firm. The management believes that too much interaction between the engineers and the client is one reason behind such a high turnover, as "engineers working with a client on site frequently received job offers from the client." One strategy that the management is contemplating is to replace on-site contracts with projects run in their own facilities "in order to reduce contact between engineers and clients so as to curtail the job offer." Once again, one can interpret such a strategy as a particular choice of an information transmission mechanism. In an on-site contract, the client (the raider) can obtain nearly perfect information about the quality of a worker. Bringing projects to its own facility allows HCL America to send only a noisy signal about its worker's quality, and thereby, possibly deter raids.

The rest of the paper is organized as follows. Section 2 provides a literature review. The model is described in Section 3 and the main results are proved in Section 4. Section 5 discusses the impact of relaxing the assumptions in the benchmark results and some characterization of the optimal noisy disclosure policy. Some extensions of the main results are considered in Section 6. Section 7 concludes. All proofs are omitted in the main text and provided in the Appendix.

## 2. RELATED LITERATURE

Ever since the seminal work by Fama (1980), many authors have contributed to the literature on career concerns. Holmström (1982) provides a classic treatment of informal incentives based on career concerns. He develops a model to show that, in absence of any formal pay-contingent contract, a worker's reputational concerns can be a solution to an agency problem. Dewatripont, Jewitt and Tirole (1999a) generalize this model and study the impact of information quality on the power of career concern incentives. In contrast to this paper, most of these works assume no information asymmetry between the current and prospective employers. (See also Scharfstein and Stein (1990), Gibbons and Murphy (1992), Jeon (1996), and Ortega (2003).)

Informational asymmetry between current and future employers opens up a role for strategic information transmission. Some authors have studied the role of information transmission in the context of publicly observed promotions and rank order tournaments. Waldman (1984) considers an environment where only the current employer knows the worker's ability. In his model, the other firms gradually learn about the worker's type by observing his job assignment. He shows that, in such environments, job assignment is often inefficient. Zábajník and Bernhardt (2001) show how information spillovers associated with rank order tournaments can generate reputational incentives. In a related paper, Koch and Peyrache (2003b) argue that, due to the information spillover effect, rank order tournament may outperform an individual performance contract.

Calzolari and Pavan (2004) are the first to endogenize the information structure in a sequential common agency game. They characterize the optimal disclosure policy in a game where trade surplus in the downstream relationship may depend on both the agent's exogenous private information and the endogenous information on the upstream principal's trade decisions. They find that it is always in the interest of the upstream principal to distort information. Under certain conditions, the upstream principal will not disclose any information at all. The rent that the upstream principal must leave to the agent for a truthful revelation of his type may more than offset the maximum rent generated in the downstream relationship through strategic information transmission. This is in contrast with this paper where no screening contract is feasible as the agent's type is unknown to all parties. Moreover, I find full disclosure can be optimal under certain conditions, whereas this is never the case in their paper. Koch and Peyrache (2003a) model a sequential labor contract scenario where the upstream principal has an informational advantage over downstream principals. As in Calzolari and Pavan (2004), they allow for screening contracts and find that the first principal will always disclose a noisy signal about the worker's quality. They also differ from this paper in certain key assumptions. In their model, a worker's future wages do not increase with his performance as output fully reveals his type. Hence, the firm may decide to pool the agents' performances to create reputational incentives. In addition, they restrict the contract space to renegotiation-proof deterministic contracts. Another important assumption in their paper is that the worker's turnover is exogenous (this is also assumed in Calzolari and Pavan (2004)). I show that endogenizing the worker's turnover decision can lead to an adverse selection problem, which feeds back to the design of the optimal disclosure policy for the upstream principal.

This paper is also related to the literature on adverse selection in labor markets. Greenwald (1986) studies the impact of adverse selection problems on wage determination and workers' mobility. The winner's curse problem in labor market has also been studied in various contexts. Waldman (1990) shows how winner's curse effects can be generated when up-out contracts are used as a signaling device. Lazear (1986) studies such effects in the context of raids and offer matching. Blanes-i-Vidal (2002) argues that an employer's authority over decision-making rights creates a winner's curse effect and dampens incentives based on career



concerns. These studies assume that the impact of the winner’s curse effect is exogenous to the upstream principal. In my analysis, this effect originates endogenously and the upstream firm can manipulate the impact of this effect through her choice of disclosure policy.

### 3. THE MODEL

**PLAYERS.** I consider a two-period principal-agent model. Agent  $A$  is employed by the upstream firm  $F$  in the first-period of his career. In the second-period,  $A$  may get offers from potential employers or “raiders”  $R_1$  and  $R_2$ . The raiders are identical firms and bid competitively to get the agent. After observing the raiders’ bid,  $F$  submits a counteroffer to  $A$ . Given the offers from  $F$  and the raiders,  $A$  decides which employer to work for in the second-period.

**TECHNOLOGY.** In the two periods of his life,  $A$  is assigned to two different tasks, which differ in technology. In the first-period,  $A$ ’s output,  $y_1 \in Y = \{y_L, y_H\}$ , where  $y_L < y_H$ , is stochastic and depends on effort and ability. The agent’s ability,  $a \in \{\underline{a}, \bar{a}\}$ , is unknown to all parties and  $\underline{a} < \bar{a}$ . The prior distribution of  $a$  is  $\Pr(a = \bar{a}) = p$ .  $A$  puts in effort  $e \in \{0, 1\}$  that is observed only by  $A$  and is, therefore, not contractible. Output is contractible but not observed by the raiding firms.

Let  $\bar{P}_1 = \Pr(y_H | e = 1, \bar{a})$  be the probability of obtaining high output when a high-ability agent puts forth effort  $e = 1$ .  $\bar{P}_0$ ,  $\underline{P}_1$  and  $\underline{P}_0$  are defined in the same way. Let  $\bar{P}_1 > \underline{P}_1$  and  $\bar{P}_0 > \underline{P}_0$ , i.e., for all effort levels, high output is more likely if  $A$  is of high ability. Moreover,  $\bar{P}_1 > \bar{P}_0$  and  $\underline{P}_1 > \underline{P}_0$ , i.e., irrespective of ability, effort increases the probability of obtaining high output. Let  $P_1 = \Pr(y_H | e = 1)$  and  $P_0 = \Pr(y_H | e = 0)$ . Note that the previous assumptions imply  $P_1 > P_0$ , i.e., the total probability of producing high output increases with effort.

There is no moral hazard problem in the second-period. Here,  $A$  is assigned to a task where output is a function of ability only. To simplify matters, assume that, for  $F$ , the output of an agent with ability  $a$  is  $y_2 = a$ . For  $R_1$  and  $R_2$ , the agent is a better match.  $A$  is at least as productive in a raider’s firm as he is in  $F$ , irrespective of his ability. Given an ability level  $a$ ,  $A$ ’s output in a raider’s firm is  $a + m$ , where  $m (> 0)$  is the matching factor.<sup>5</sup> The value of  $m$  is known to all players.

**CONTRACT DESIGN.**  $F$  can provide incentives to  $A$  through two channels. First, it can pay for performance, i.e., choose wage payments conditional on output. Second, it can rely on the agent’s career concerns. As the agent’s ability is unknown, prospective employers update their beliefs about  $A$ ’s ability conditional on the information they receive on  $y_1$ .  $F$  can strategically disclose information to the raiders that manipulates their posterior belief and, hence, their subsequent wage offer to  $A$ .

<sup>5</sup>To motivate this assumption, one can think in the following terms. Firms differ in terms of their matching factors, but only the ones with the highest factor care to bid, as raiders compete in prices to win the agent. I assume that the highest value of this factor is non-negative.

In the most general specification of the model,  $F$  offers a **long-term complete contract** to  $A$  at the beginning of period-one. The contract specifies for: i) wages in period-one, ii) a disclosure policy (which I shall formally define later), iii) wages in period-two if  $A$  continues to work under  $F$ , and iv) a severance payment in case  $A$  leaves the firm.

Let the contract be denoted by a mapping  $\phi_F = (\phi_F^1, \phi_F^2)$  where  $\phi_F^1 : Y \rightarrow \Delta(X \times W)$ , and  $\phi_F^2 : Y \times X \rightarrow W^2$ .

$\phi_F^1$  maps  $y_1$  into a joint probability distribution over  $X$ , a set of signals that  $F$  discloses to  $R_1$  and  $R_2$ , and a set of possible wage payments,  $W \subseteq \mathbb{R}$ . The first-period wage,  $w_1 \in W$ , is paid at the end of period-one. The mapping  $\phi_F^1$  also induces a disclosure policy  $\delta : Y \rightarrow \Delta X$ . Given  $y_1$ ,  $F$  sends a signal,  $x \in X$ , according to the distribution,  $\delta(x | y_1)$ . One can think of the disclosure policy as a “garbling” of  $y_1$  that  $F$  allows the raiders to observe. The definition of such a contract implicitly assumes that the firm can credibly commit to a pay-per-performance contract as well as a disclosure policy. If any information is revealed, it is revealed to both raiders. There is no information asymmetry between the raiding firms.

$\phi_F^2$  maps the tuple  $(y_1, x)$  to a wage payment,  $w_2 \in W$ , if  $A$  continues to work for  $F$  and a severance payment,  $s \in W$ , if he leaves. Both payments are made at the end of period-two.<sup>6</sup>

In contrast, when only a **short-term performance contract** is feasible, the firm is assumed to have no commitment power over second-period wages and severance payments. I define a short-term performance contract as a special case of a long-term complete contract, where  $w_2 = s = 0 \forall (y_1, x) \in Y \times X$  and the period-one wage is a deterministic function of the realized output. A short-term performance contract specifies only the i) wages in period-one and ii) a disclosure policy as defined above.<sup>7</sup>

In the second-period, the wage (or “bid”),  $b_i$ , that raider  $R_i$  offers is a mapping from the set of signals that he may receive to the set of wages,  $W$ ,  $b_i : X \rightarrow W$ ;  $i = 1, 2$ . Let  $B$  be the set of all such mappings.

Observing  $b_1$  and  $b_2$ ,  $F$  can match the best offer. Based on output  $y_1$  and bids  $\mathbf{b} = (b_1, b_2)$ ,  $F$  offers a new pair  $(\hat{w}_2(\mathbf{b}, y_1), \hat{s}(\mathbf{b}, y_1))$  such that  $\hat{w}_2 \geq w_2$  and  $\hat{s} \geq s$ . Thus, the firm cannot take away the offer that the initial contract specifies, but she can offer a better deal to the agent.<sup>8</sup>

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<sup>6</sup>I focus on this specific form of long-term complete contracts to keep the model analytical simple. In fact, the most general class of long-term complete contracts is of the form  $\phi_F : Y \rightarrow \Delta(X \times W^3)$  where the firm offers a lottery over the signals, period-one wage and period-two wage/severance payments. However, the results of this paper are robust to such generalization.

<sup>7</sup>Note that, in a short-term contract,  $F$  can still commit to a disclosure policy even though the second period payments (conditional on the realized signal) are not contractible. One can motivate this assumption in the context of job design. Suppose every job, depending on its underlying technology, reveals some information about  $A$ 's ability to the raiders.  $F$  may not directly observe what information the raiders have and, hence, cannot write a complete contract. But she can influence the flow of information by choosing a particular job design.

<sup>8</sup>As under a short-term performance contract  $s = 0$ , in equilibrium  $\hat{s} = 0$ .

After receiving the second-period offers,  $A$  works for the firm that offers the highest *net transfer*.<sup>9</sup> I assume that, if  $F$ 's counteroffer makes  $A$  indifferent between staying and leaving,  $A$  stays with  $F$ . Otherwise,  $A$  leaves for the raider with the highest bid. In case of a tie, he chooses  $R_1$  or  $R_2$  with equal probability. For the sake of simplicity, I assume that  $A$  cannot participate in the “old-agent market” unless he works with  $F$  as a “young” agent. One way to interpret this assumption is that  $F$  provides some exclusive “on the job training” to the agent in period-one. This is indispensable for performing the second-period task.

PAYOFFS. The payoff to the agent is:

$$(1) \quad U(t_1, t_2, e) = u(t_1, t_2) - \psi(e),$$

where  $t_\tau$  is the net transfer received by  $A$  in period  $\tau$ ,  $\tau = 1, 2$ . Thus,  $t_1 \equiv w_1$  and  $t_2 = \max\{w_2, b_1 + s, b_2 + s\}$ . Let  $u$  be strictly increasing and concave in both arguments,  $\psi(1) = \psi$  and  $\psi(0) = 0$ . The reservation payoff for  $A$  is normalized to 0.

The firm's payoff  $\Pi$  is the sum of its profits in the two periods; i.e.,  $\Pi = \pi_1 + \pi_2$  where  $\pi_1 = (y_1 - w_1)$  and  $\pi_2 = (y_2 - w_2)$  if  $A$  works for the firm and  $(-s)$  otherwise. I assume that it is always optimal for  $F$  to induce  $e = 1$ .

TIMING. The timing of the game is as follows:

- At the beginning of **period 1**,  $F$  offers a contract,  $\phi_F$ , to the agent. If  $A$  rejects the contract, all players get their reservation payoff 0 in both periods and the game ends. If  $A$  accepts  $F$ 's offer, the game continues on to period 1.1.
- At **period 1.1**,  $A$  chooses his effort level,  $e \in \{0, 1\}$ .
- At the end of **period 1**, the first-period output is realized.  $F$  pays first-period wages,  $w_1$ , and discloses information  $x$  to the raiders.
- At **period 2**,  $R_1$  and  $R_2$  bid for the agent after observing the information,  $x$ , disclosed by  $F$ .
- At **period 2.1**, After observing the raiders' bids,  $F$  decides whether to match the best offer; i.e.,  $F$  may announce a second-period wage-severance payment pair  $(\hat{w}_2, \hat{s})$ .
- At **period 2.2**,  $A$  chooses his new employer.
- At the end of **period 2**, the second-period output is realized.  $A$  receives payment from his current employer (and severance payments from  $F$  if there was a turnover); at this point, the game ends.

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<sup>9</sup>It is important to note that, under a long-term contract,  $A$  will not necessarily leave for the highest paying firm. If there is a severance payment enforced by the contract,  $A$  will compare the wages net of the severance payment while choosing his employer.

STRATEGIES AND EQUILIBRIUM. This paper focuses only on pure strategies, due to their analytical tractability. A pure strategy for  $F$ ,  $\sigma_F$ , has two components. In the first-period,  $F$  chooses a contract,  $\phi_F$ . In the second-period, given the tuple  $(\mathbf{b}, y_1)$ ,  $F$  offers a revised wage-severance payment  $(\hat{w}_2, \hat{s})$  to  $A$ .  $A$ 's pure strategy,  $\sigma_A$ , also has two components. In period-one,  $A$  decides whether to accept the contract,  $\phi_F$ , and whether to put in effort if he does decide to accept the offer. In period-two,  $A$  chooses his employer once he observes the offers from all players. A pure strategy for the raiders is a mapping  $b_i \in B$  conditional on  $F$ 's choice of  $\phi_F$ .

*Perfect Bayesian Equilibrium* is used as a solution concept. The strategies  $\langle \sigma_F, \sigma_A, b_i \rangle_{i=1,2}$  constitute a *PBE* if:

- each firm announces a sequentially rational contract given the strategies of the other firm and the agent;
- for each signal  $x$  in the equilibrium path, the raiders update their beliefs according to the Bayes Rule; and
- the agent takes a payoff-maximizing decision at each node where he is called upon to play.

The following section discusses the optimal disclosure policy and establishes two benchmark results given the firm's strategies.

#### 4. BENCHMARK RESULTS: THE OPTIMALITY OF FULL DISCLOSURE

This section proves two benchmark results that provide a set of conditions under which full disclosure is optimal for  $F$ . The first result considers the case where  $F$  can use long-term complete contracts. I show that the optimal long-term complete contract always induces full disclosure when the raider market is perfectly competitive. The second result considers the case where long-term complete contracts are not feasible. I show that the optimal short-term performance contract induces full disclosure if i)  $A$  is risk neutral, ii)  $A$  does not face any liquidity constraint, and iii) the raider market is perfectly competitive. Moreover, under these conditions, the optimal short-term performance contract yields the same profit as the optimal long-term contract.

The following notations will be useful in establishing these results. Upon receiving signal  $x \in X$ , the raiders form a belief about the ability of  $A$ . Let  $\mu(a | x)$  be the raiders' posterior, i.e.,

$$\mu(a | x) = \frac{\sum_{y_1} \delta(x | y_1) \Pr(y_1 | a) \Pr(a)}{\sum_{\tilde{a}} \sum_{y_1} \delta(x | y_1) \Pr(y_1 | \tilde{a}) \Pr(\tilde{a})}.$$

As  $F$  may hold more information than the raiders about the agent, raiders face a potential adverse selection problem which affects their bids. The program that raider  $R_i$  ( $i = 1, 2$ ) solves under a long-term complete contract is:

$$\max_{b_i \in B} \mathbb{E}_{(a, y_1) | x} (a - b_i) \mathbb{I} \{b_i + \hat{s}(\mathbf{b}, y_1) \geq \max \{b_j(x) + \hat{s}(\mathbf{b}, y_1), \hat{w}_2(\mathbf{b}, y_1)\}\},$$

where  $\mathbb{I}(\cdot)$  is an indicator function (recall that  $y_2 = a$ ). Denote  $\mathbb{E}(a | y_i) = \bar{a}_i$  ( $i = H, L$ ) as the *posterior type* of agent. In what follows, the agent “type” refers to his *posterior type* unless indicated otherwise. As the raider market is perfectly competitive, in equilibrium, each raider’s bid must be equal to the expected productivity of the agent conditional on the realized signal and the event of winning the bidding competition (given the strategy of  $F$ ). If the highest bid is less than  $\bar{a}_H$ , but greater than  $\bar{a}_L$ ,  $F$  will match the raider’s offer only in the case of a high-type agent. If, instead, it exceeds  $\bar{a}_H$ ,  $F$  will let the agent leave. Whenever the expected productivity of  $A$  as perceived by the raiders (i.e.,  $\mathbb{E}(a | x) + m$ ) is less than the productivity of the high-type (i.e.,  $\bar{a}_H$ ), a bid of  $\mathbb{E}(a | x) + m$  can only win a low-type agent. Therefore, the raiders will shade their bid below  $\mathbb{E}(a | x) + m$ . This is similar to the winner’s curse effect in a common value auction when bidders may have different information about the value of the object.

To make the analysis interesting, Assumption 1 ensures that the winner’s curse is indeed a relevant consideration for the raiders while they choose their bids.

**Assumption 1.**  $\bar{a}_L + m < \bar{a}_H$ .

This assumption puts an upper bound on the matching factor,  $m$ . If  $m$  is so large that the productivity of the low-type agent in the raider’s firm (i.e.,  $\bar{a}_L + m$ ) is greater than the productivity of the high-type agent in  $F$  (i.e.,  $\bar{a}_H$ ), then the winner’s curse effect disappears. As  $A$ ’s expected productivity in the raider’s firm is at least  $\bar{a}_L + m$ , if  $\bar{a}_L + m > \bar{a}_H$ , there is turnover for both types of agents whenever the raider bids its expected productivity of  $A$ .

I shall now characterize the raider’s bid as a function of the realized signal. Observe that perfect competition in the raider market implies  $b_1(x) = b_2(x) = b(x)$  for all  $x \in X$ . Under Assumption 1, due to the winner’s curse effect, the raiders will bid the expected productivity of the agent only if it is greater than the productivity of the high-type in  $F$ . Otherwise, the raiders will bid only for the low-type as  $F$  will always match the highest bid if  $A$  is of the high-type. The following lemma summarizes this argument.

**Lemma 1.** *Under Assumption 1, under both long-term complete contracts and short-term performance contracts, the raider’s bid conditional on the signal  $x$  is  $b_1(x) = b_2(x) = b(x)$ , where*

$$(2) \quad b(x) = \begin{cases} \mathbb{E}(a | x) + m & \text{if } \mathbb{E}(a | x) + m > \bar{a}_H \\ \bar{a}_L + m & \text{otherwise} \end{cases}.$$

*Proof.* See Appendix A. ■

By virtue of Lemma 1, the final wage-severance payment offer of  $F$  can be written as  $(\hat{w}_2(x, y_1), \hat{s}(x, y_1))$ . It also implies that the period-two profit of  $F$  given  $\sigma_F$  is

$$\pi_2(x, y_1 | \sigma_F) = \begin{cases} \mathbb{E}(a | y_H) - \hat{w}_2(x, y_H) & \text{if } \mathbb{E}(a | x) + m \leq \bar{a}_H \text{ and } y_1 = y_H \\ -\hat{s}(x, y_1) & \text{otherwise} \end{cases},$$

and the second-period net transfer to  $A$  is:

$$t_2(x, y_1 | \sigma_F) = \begin{cases} \hat{w}_2(x, y_H) & \text{if } \mathbb{E}(a | x) + m \leq \bar{a}_H \text{ and } y_1 = y_H \\ b(x) + \hat{s}(x, y_1) & \text{otherwise} \end{cases}.$$

(Recall that, in a short-term contract,  $\hat{s} = 0$  for all  $(x, y_1)$ .) Figure 1 shows the raider's bid as a function of expected productivity as derived in Lemma 1.

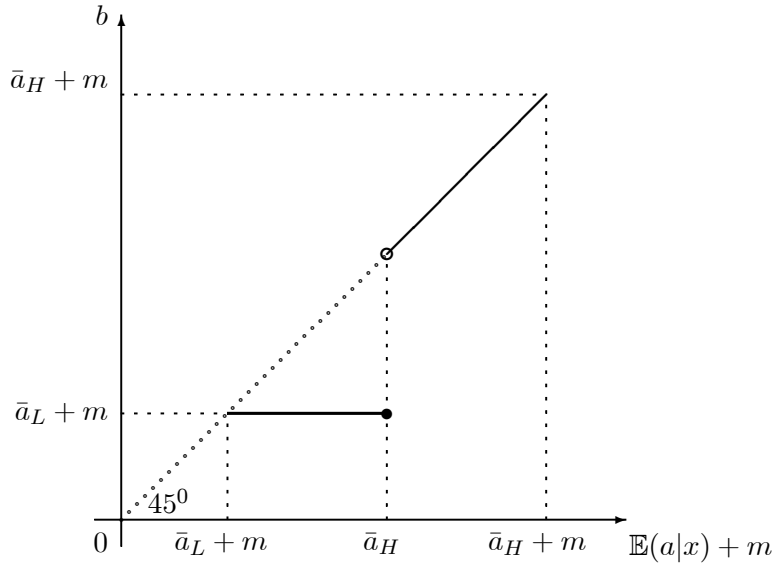


Figure 1. Raider's bid as a function of expected productivity (shown by solid lines).

There are three salient features of this bidding strategy. First, a raider wins the agent only if the raider's bid is higher than the valuation of the agent inside the incumbent firm. The agent with type  $i$  leaves if and only if  $\bar{a}_i < b$ ,  $i = L, H$ . Thus, the outcome of this bidding game is the same as when the agent and the firm jointly bargain with the raiders and always make the efficient trading decision given the bids.

Second, whenever the expected productivity of  $A$  in a raider's firm is less than  $\bar{a}_H$ , the raider bids the lowest valuation,  $\bar{a}_L + m$ . A raider's bid as a function of expected productivity of the agent is not continuous at the point  $\bar{a}_H$  and, hence, not a convex function. There are further implications of such nonconvexity to which I shall return later.

Third, both short-term and long-term contracts lead to the same bidding function and ex post employment of  $A$ . Here a long-term contract does not create any barrier to entry. Given that  $F$  can increase the severance payment ex post, promising a high second-period wage ex ante has no effect on who  $A$  ultimately works for.

Let  $X(\delta) = \{x \mid \delta(x \mid y) > 0 \text{ for some } y \in Y\}$ , i.e., the set of signals that are used in the equilibrium with positive probabilities. Define information disclosure as follows:

**Definition 1.** A contract,  $\phi_F$ , is said to disclose information iff there exist two distinct signals,  $x_l, x_k \in X(\delta)$ , such that  $\mu(\bar{a} \mid x_l) \neq \mu(\bar{a} \mid x_k)$ .

Let  $\mathbb{E}_{(x,y_1)} [u(t_1, t_2) \mid \sigma_F, \tilde{e}] - \psi(e)$  be  $A$ 's expected utility when he puts in an effort,  $e$ , and the outside market believes the effort level to be  $\tilde{e}$  (given the strategy  $\sigma_F$  of  $F$ ). Let  $\tilde{\mathbb{E}}$  be the expectation operator when  $e$  is set at  $\tilde{e}$ . The equilibrium strategy of  $F$  must maximize the expected profit from the two periods conditional on  $A$  accepting the contract (individual rationality) and having incentives to put in a high effort (incentive compatibility). Hence the optimal contract must solve the following program for  $F$ :

$$\mathcal{P} \begin{cases} \max_{\sigma_F} & \mathbb{E}_{y_1} \pi_1 + \mathbb{E}_{y_2, x} \pi_2 \\ \text{s.t.} & \mathbb{E}_{(x,y_1)} [u(t_1, t_2) \mid \sigma_F, \tilde{e} = 1] - \psi \geq \quad (IC) \\ & \mathbb{E}_{(x,y_1)} [u(t_1, t_2) \mid \sigma_F, \tilde{e} = 1] \\ & \mathbb{E}_{(x,y_1)} [u(t_1, t_2) \mid \sigma_F, \tilde{e} = 1] - \psi \geq 0. \quad (IR) \end{cases}$$

I define full transparency (or full disclosure) as follows:

**Definition 2.**  $F$  is said to be fully transparent if the optimal contract involves a disclosure policy  $\delta$  that unambiguously discloses the information on  $y_1$ , i.e.,  $\exists$  two signals  $x_L, x_H \in X(\delta)$  such that:

$$\delta(x_H \mid y_H) = \delta(x_L \mid y_L) = 1 \quad \text{with } x_H \neq x_L .$$

The benchmark results of this paper provide a set of conditions under which the optimal disclosure policy for  $F$  is fully transparent. The first benchmark result considers the case where  $F$  can use long-term complete contracts.

**Proposition 1.** If  $F$  can use long-term complete contracts and the raider's market is perfectly competitive, then full transparency is optimal.

*Proof.* See Appendix A. ■

The intuition behind this result is the following. By assumption,  $A$  is more productive with the raiders. Hence, social surplus is maximized when  $A$  leaves for the raiding firm irrespective of his type. With partial disclosure, there is a positive probability that  $F$  will retain the high-type agent. This leads to an inefficient level of trade. Full disclosure ensures

the maximum possible trading surplus in the raiding game. It also increases the career concern-based incentives of the agent. As the raider's market is perfectly competitive,  $A$  is offered all of the matching surplus, which  $F$  can appropriate up front.

But if  $A$  is risk averse, then full disclosure may have an additional cost. When  $F$  moves from partial to full disclosure,  $A$  faces more human capital risk. As his second-period wage depends on the realized signal, the spread of second-period wages increases under full disclosure. The firm may need to pay a high risk premium to the agent to ensure that he accepts the contract. This additional premium, in turn, might more than offset the gains from trade and make full disclosure a suboptimal strategy. However, feasibility of a long-term complete contract ensures that the utility levels of the agent can be tailored for every output-signal pair. By choosing severance payments that allows  $A$  to obtain exactly the same net transfer as before for every output-signal realization,  $F$  can shield  $A$  from such human capital risk and maintain the same incentives. Hence, if  $F$  can use a long-term complete contract, she can resort to full transparency in order to appropriate maximum gains from trade.

The intuition for Proposition 1 can be applied to long-term complete contracts that are no longer feasible. In my second benchmark result, I show that, under certain conditions, a short-term performance contract with full transparency can implement the same outcome of an optimal long-term complete contract. Thus, without loss of optimality,  $F$  can restrict itself to the class of short-term performance contracts with full transparency if these conditions are satisfied.

**Proposition 2.** *An optimal short-term performance contract induces full disclosure if i)  $A$  is risk neutral, ii)  $A$  faces no liquidity constraint, and iii) the raider market is perfectly competitive.*

*Proof.* See Appendix A. ■

The intuition behind this result is the same as in Proposition 1; i.e., greater transparency leads to the full realization of gains from trade. In the context of short-term performance contracts, there are two additional considerations, which are absent when long-term complete contracts are feasible. First, a short-term performance contract cannot insure the agent from human capital risk. Hence, the risk neutrality condition is introduced. Second, to appropriate the gains from trade in a short-term contract,  $F$  must adjust  $A$ 's wages in the first-period. This may require a negative wage payment in period-one. If  $A$  faces a liquidity constraint, his net transfer in each period has to be non-negative, ruling out any negative wage payments. This observation justifies the “no liquidity constraint” assumption.

Recall that this no-liquidity-constraint condition was not invoked in the context of long-term complete contracts. When long-term complete contracts are feasible,  $F$  can adjust  $A$ 's severance payment in period-two to appropriate the gains from trade. However, in the second-period,  $A$  also earns wages from his new employer, and he can accommodate a negative severance payment with these wages.



The two benchmark results show that, under certain conditions, the maximum profit is obtained by the firm when she is fully transparent. One may ask whether the firm’s profit monotonically increases with the quality of the disclosed information. Consider a disclosure policy where  $F$  sends no information to the raiders. Thus, the raiders’ prior and posterior beliefs are identical. This is the most coarse information that  $F$  can send to the raiders. The benchmark results show that full disclosure dominates such coarse information transmission. But does poorer quality of information transmission always hurt the firm? If the prior belief is sufficiently favorable to the high-type agent, then the answer is “no”. To understand the intuition, consider Figure 2.

The raiders’ bid is plotted as a function of the expected productivity of the agent in the raider’s firm, conditional on  $x$ . Let  $\mathbb{E}(a) + m > \bar{a}_H$ . If no information is disclosed, there is a turnover for both types. The raiders’ bid is equal to the prior belief about the agent’s productivity (point  $b''$  in Fig. 2). Suppose  $F$  partially discloses information about the agent’s type using two signals,  $x_L$  and  $x_H$ . Let the raider’s posterior belief about the agent’s productivity upon receiving the signal  $x_L$  ( $x_H$ ) be  $l$  ( $h$ ). The expected bid, as Fig. 2 shows, is now  $b' < b'' = \mathbb{E}(a) + m$ . This is due to the nonconvexity in the bid function. The resulting lower bid reduces  $F$ ’s profit.

Proposition 3 establishes this intuition rigorously in the context of long-term contracts. In the context of short-term contracts, the proof is similar and is omitted here.

**Proposition 3.** *Let the raider market be perfectly competitive. Denote the maximum payoff to  $F$  with no information disclosure as  $\Pi^{ND}$ . Consider any partial disclosure policy,  $\delta^{PD}$ , where the high-type agent faces a bid equal to  $\bar{a}_L + m$  with nonzero probability. Let the maximal payoff to  $F$  associated with  $\delta^{PD}$  be  $\Pi^{PD}$ . If  $\mathbb{E}(a) + m > \bar{a}_H$ , then  $\Pi^{ND} > \Pi^{PD}$ .*

*Proof.* See Appendix A. ■

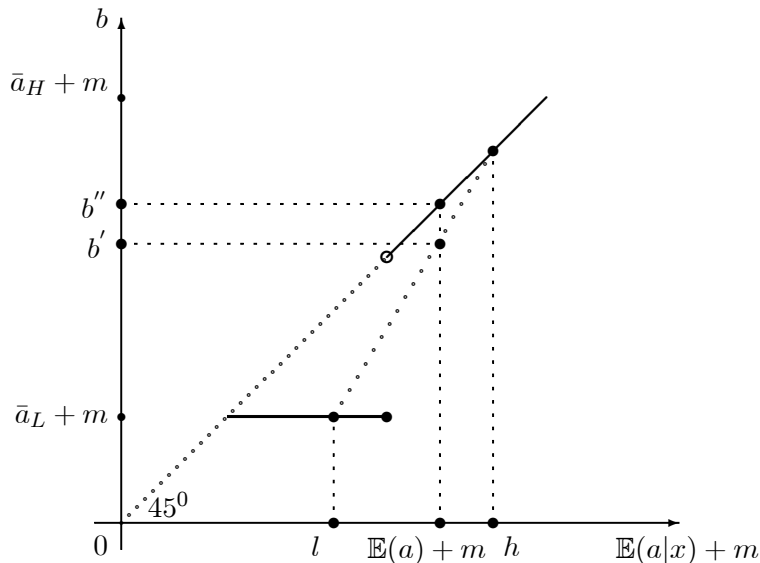


Figure 2. Case where no information disclosure dominates a partial disclosure policy.

The key observation here is that partial information disclosure may lead to an inefficient volume of trade. If the players' prior beliefs are sufficiently biased towards the high-type agent, the trade-volume can be at the efficient level under no disclosure. By pooling the high-type agent with the low-type, the high-type may face a low bid and may end up with  $F$ . Hence, a partial move towards transparency may worsen the situation. It is worth noting that, if  $\mathbb{E}(a) + m > \bar{a}_H$ , then no disclosure is also optimal.  $F$  is indifferent between no disclosure and full disclosure but prefers both to partial disclosure.

The conditions invoked in Propositions 1 and 2 are sufficient for full transparency. They are also “almost” necessary; by relaxing any of these conditions, one can find preferences for the agent and suitable parameters of the model where full disclosure is no longer optimal. The following section provides a characterization of the optimal disclosure policy when the conditions of the benchmark propositions are relaxed.

## 5. PARTIAL DISCLOSURE AS THE OPTIMAL POLICY

This section shows that the optimal disclosure policy may not be fully transparent in the absence of any of the three conditions invoked in the benchmark results. In the following subsections, I shall examine these conditions one at a time and characterize the optimal disclosure policy.

**5.1. Raider with Monopsony Power.** Let there be only one raider who bids for the agent. As the bidder now enjoys monopsony power, the raider's bid in equilibrium does not reflect the true productivity of the agent in the raider's firm. The bidding strategy of the monopsonistic raider is:

$$(3) \quad b(x) = \begin{cases} \bar{a}_H & \text{if } \mathbb{E}(a | x) > \bar{a}_H - P_1 m \\ \bar{a}_L & \text{otherwise} \end{cases} .$$

Recall that  $P_1$  is the probability that the agent is of a high type. The argument is again based on the adverse selection problem. All bids in the interval  $(\bar{a}_L, \bar{a}_H)$  are dominated by the bid  $b = \bar{a}_L$  as they are sure to win only the low-type agent. With a bid equal to  $\bar{a}_H$ , the raider wins both types; thus, by paying more than  $\bar{a}_H$  the raider is necessarily overbidding. Hence, the raider will bid  $\bar{a}_H$  if the expected profit from such a bid is greater than the profit associated with the bid  $\bar{a}_L$ . Now,  $(1 - P_1)$  is the probability that the agent is of a low-type. By bidding  $\bar{a}_L$ , the raider wins the low-type agent and gains  $m$  on him. On the other hand, by bidding  $\bar{a}_H$ , his expected profit is  $\mathbb{E}(a | x) + m - \bar{a}_H$ . Hence, the raider will bid  $\bar{a}_H$  if  $\mathbb{E}(a | x) + m - \bar{a}_H > (1 - P_1) m$ .

In this scenario, without loss of generality,  $F$  needs to disclose only two signals,  $x_H$  and  $x_L$ , such that  $b(x_H) = \bar{a}_H$  and  $b(x_L) = \bar{a}_L$ . To understand the reason, consider any set of signals  $X$ . Let  $X_L \subseteq X$  and  $X_H = X \setminus X_L$  be such that  $b(x) = \bar{a}_i \forall x \in X_i, i = L, H$ . One can then replace all the elements in,  $X_L$  ( $X_H$ ), with one signal  $x_L$  ( $x_H$ ) that is used with the aggregate probability of initially using signals in  $X_L$  ( $X_H$ ), given  $y_1$ . A disclosure

policy, therefore, can be characterized by a tuple  $\delta = (\alpha_L, \alpha_H)$ , where  $\alpha_i = \Pr(x_H | y_i)$ ,  $i = L, H$ . Let  $\alpha_i^*$  be the corresponding equilibrium value. With full transparency, as before, gains from trade are maximized, but the raider appropriates them entirely. In this case, the incumbent firm can appropriate an informational rent by suitably pooling the two types of agents. By allowing the low-type to earn an informational rent,  $F$  can appropriate it up front. Proposition 4 summarizes this observation.<sup>10</sup>

**Proposition 4.** *If the raider is a monopsonist, both short and long-term optimal contracts induce no information disclosure if  $\mathbb{E}(a) > \bar{a}_H - P_1 m$ . Otherwise, the optimal disclosure policy is of the form  $\alpha_H^* = 1$  and  $\alpha_L^* > 0$ , where  $(\alpha_H^* = 1, \alpha_L^*)$  solves  $\mathbb{E}(a | x_H) = \bar{a}_H - P_1 m$ .*

*Proof.* See Appendix A. ■

Proposition 4 indicates that the optimal partial disclosure policy is of the form (arrows represent the pattern of signalling):

$$\begin{array}{ccc} y_H & \rightarrow & x_H \\ & \nearrow & \\ y_L & \rightarrow & x_L \end{array},$$

where the low-type is sometimes traded as a high-type agent. This result relies on a simple intuition.  $F$  prefers to induce the highest bid from the raiders for all agent types, without distorting the trade volume. In so doing,  $F$  can appropriate the maximum surplus from  $A$ . If  $\mathbb{E}(a) > \bar{a}_H - P_1 m$ , then, with no disclosure, the raider will bid  $\bar{a}_H$  — the highest bid that can arise in any equilibrium. In contrast, if  $\mathbb{E}(a) \leq \bar{a}_H - P_1 m$ , no disclosure leads to a low bid ( $\bar{a}_L$ ) for all types of agents.  $F$  can increase the bid with a positive probability by reporting  $x_H$  when  $y_1 = y_H$ . However, full disclosure is not optimal either.  $F$  can pool a low-type agent with the one of high type exactly up to the level where the high-type agent still receives a high offer of  $\bar{a}_H$ . Thus,  $F$  may also report  $x_H$  with a positive probability when  $y_1 = y_L$  and ensure a bid of  $\bar{a}_H$  even for the low-type agent.

Calzolari and Pavan (2004) derives a similar result in the context of sequential contracting. They show that the extent of information disclosure between upstream and downstream principals depends on, among other things, how favorable the prior belief of the downstream principal is about the agent when no information is disclosed.

The requirement of trading efficiency puts a lower bound on the optimal  $\alpha_L$ . This observation leads to the following comparative statics result.

**Corollary 1.** *If  $\mathbb{E}(a) \leq \bar{a}_H - P_1 m$ , then  $\partial \alpha_L^* / \partial m > 0$  under both long and short-term contracts.*

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<sup>10</sup>For the sake of brevity, while stating the propositions in this section, I will only mention the condition that is relaxed. The other two conditions are assumed to be in place unless mentioned otherwise.

*Proof.* See Appendix A. ■

Intuitively speaking, with a high  $m$  the raider is more likely to bid a high value as the gains for trade outweigh the adverse selection cost (drawing a low-type agent while paying for the high-type). Hence, a greater degree of pooling will not distort the volume of trade.

**5.2. Liquidity Constraint on Agent.** When the agent faces a liquidity constraint, his net transfer in each period must be non-negative; i.e.,

$$(4) \quad t_\tau \geq 0, \tau = 1, 2.$$

Proposition 2 shows that “no liquidity constraint on  $A$ ” is one of the three conditions under which the optimal short-term performance contract induces full transparency. To understand why this condition is useful, consider any feasible solution to the optimal contracting problem where disclosure is partial. In this case, gains from trade are not fully realized. On the other hand, under partial disclosure,  $F$  may retain a high-type agent at the wage of a low-type agent and earn an informational rent. This rent disappears if  $F$  is fully transparent. When  $F$  moves from partial disclosure to full transparency, if she can adjust the first-period wages of  $A$ , then the gain from efficient trading outweighs the loss of informational rent. However, that may require a negative first-period wage for  $A$ .<sup>11</sup> If  $A$  faces a liquidity constraint, such wage adjustments are not feasible. In this environment, the informational rent that  $F$  can enjoy in a partial disclosure policy can be greater than the gains from an efficient trade that  $F$  can appropriate up front.

To understand this, consider a short-term performance contract where period-one wages are set at zero and the disclosure policy is fully transparent. Let both  $(IC)$  and  $(IR)$  be slack in this contract; i.e.,

$$(5) \quad (P_1 - P_0)(\bar{a}_H - \bar{a}_L) > \psi \quad \text{and} \quad \mathbb{E}(a) + m > \psi.$$

Therefore, this contract is a feasible solution to the optimal contracting problem  $\mathcal{P}$ .

Take  $X = \{x_L, x_H\}$ . As before, a disclosure policy can be characterized by a tuple  $\delta = (\alpha_H, \alpha_L)$ , where  $\alpha_i = \Pr(x_H | y_i)$ ,  $i = L, H$ . Recall that under full disclosure,  $b(x_i) = \bar{a}_i + m$ ,  $i = L, H$ , and there is a turnover for both types. With a liquidity constraint in place,  $F$  will set  $w_1(y_L) = w_1(y_H) = 0$  under full disclosure, and its profit will be  $\mathbb{E}y_1$ .

Suppose that  $F$  pools the high-type agent with the low-type with a positive probability, i.e.,  $\alpha_H < 1$ . The disclosure policy then takes on the following form (arrows represent the pattern of signalling):

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<sup>11</sup>Recall that, under a short term performance contract,  $F$  has no commitment over  $A$ 's second period wages and severance payments.

$$\begin{array}{ccc} y_H & \rightarrow & x_H \\ & \searrow & \\ y_L & \rightarrow & x_L \end{array} .$$

Let  $(1 - \alpha_H)$  be sufficiently small such that  $b(x_L) = \bar{a}_L + m$  and both  $(IC)$  and  $(IR)$  are still satisfied.  $F$  now enjoys not only a first-period's profit,  $\mathbb{E}y_1$ , but also a second-period one equal to  $(1 - \alpha_H)(\bar{a}_H - (\bar{a}_L + m))$ . The latter arises from the possibility of retaining the high-type agent at the market wage of a low-type agent.

In fact, liquidity constraint matters only when (5) holds.

**Proposition 5.** *Suppose  $A$  is liquidity constrained. The optimal short-term contract induces partial disclosure if and only if condition (5) is satisfied.*

*Proof.* See Appendix A. ■

The “*if*” part is already argued in the discussion above. I shall now elaborate on the “*only if*” part. Proposition 5 suggests that, in the absence of a first-period wage, if full transparency is not a feasible solution to the optimal contracting problem (i.e., if either  $(IC)$  or  $(IR)$  in  $\mathcal{P}$  is violated), the optimal short-term contract induces full transparency even if  $A$  is liquidity constrained. In other words, “no liquidity constraint” is a necessary condition for full transparency only if the career concern incentive is strong (i.e.,  $(\bar{a}_H - \bar{a}_L)$  is large) and the raider’s prior expectation of  $A$ ’s productivity is sufficiently high (i.e.,  $\mathbb{E}(a) + m$  is large).

The intuition behind this result is the following. If condition (5) is violated, then one of the following cases must be true.

$$(5') \quad (a) \quad (P_1 - P_0)(\bar{a}_H - \bar{a}_L) \leq \psi \text{ or } (b) \quad \mathbb{E}(a) + m \leq \psi.$$

As  $F$  moves from partial disclosure to full transparency, the expected bid for the low-type agent decreases (weakly) while that of the high-type agent increases (weakly). First, consider the case where only condition (b) in (5') holds; i.e., under full transparency,  $A$ ’s  $(IC)$  constraint is satisfied even in the absence of a first-period wage, but  $(IR)$  is not.  $F$  can now pay a fixed wage to make  $A$ ’s  $(IR)$  constraint bind. By doing so,  $F$  necessarily appropriates the gains from trade that full transparency offers. This observation follows from the fact that the raider’s market is perfectly competitive (and, hence, earns zero profit) and  $A$  obtains no rent. Trivially, the liquidity constraint does not bind here.

Second, consider the case when condition (a) in (5') holds; i.e., in the absence of a first-period wage,  $A$ ’s  $(IC)$  constraint is violated under full transparency. Take any arbitrary solution to the optimal contracting problem that involves partial disclosure. As the solution is feasible, it must satisfy the  $(IC)$  and liquidity constraints. Suppose that  $F$  moves from partial disclosure to full transparency, and readjusts  $A$ ’s first-period wages, such that  $A$ ’s expected payoff conditional on  $y_1$  is unchanged. Thus,  $F$  lowers  $w_1(y_H)$  and raises  $w_1(y_L)$  to  $\hat{w}_1(y_H) <$

$w_1(y_H)$  and  $\hat{w}_1(y_L) > w_1(y_L)$ . If  $F$  can do this without violating the liquidity constraints, she appropriates the entire gain from trade. Note that the  $(IC)$  and  $(IR)$  constraints of  $A$  are not affected by such wage adjustments. I argue that, if  $(a)$  is satisfied, these adjustments are indeed feasible. Observe that  $\hat{w}_1(y_L)$  satisfies the liquidity constraint by construction. Moreover, it must be true that  $\hat{w}_1(y_H) > \hat{w}_1(y_L)$ , or  $(IC)$  is violated by  $(a)$ . Therefore,  $\hat{w}_1(y_H)$  also satisfies the liquidity constraint.

**5.3. Risk Averse Agent.** This subsection relaxes the risk neutrality condition invoked in Proposition 2. Disclosure of performance exposes  $A$  to human capital risk. When  $A$  is risk averse,  $F$  is required to pay an additional risk premium to pursue  $A$  to accept the contract. I have already argued that, under long-term complete contracts, the firm can fully insure the agent from such risk. However, if only short-term contracts are viable, the risk premium that  $F$  must pay  $A$  under full transparency may be too high compared to the associated gains from trade.

The optimal disclosure policy under a short-term contract trades off the gains from trade against the cost of the additional risk premium. short-term performance contracts can partially countervail the human capital risk by appropriately adjusting first-period wages. In general, though it may not be possible to eliminate the additional risk completely. Therefore, full transparency is often suboptimal. The following example illustrates this fact.

**Example 1.** Let the utility of the agent be of the form  $U(t_1, t_2) = u(t_1) + u(t_2) - \psi(e)$ . Take  $X = \{x_L, x_H\}$ . Denote  $b_i = b(x_i)$ ,  $w_i = w_1(y_i)$ ,  $i = L, H$  and let  $b_H \geq b_L$ . As before, a disclosure policy can be characterized by a tuple  $\delta = (\alpha_H, \alpha_L)$  where  $\alpha_i = \Pr(x_H | y_i)$ ,  $i = L, H$ . Let  $P_1 > \frac{1}{2}$ ,  $\mathbb{E}(a) + m < \bar{a}_H$  and  $(P_1 - P_0)(u(\bar{a}_H) - u(\bar{a}_L)) < \psi$ . These assumptions ensure that  $b_L = \bar{a}_L + m$  and  $(IC)$  and  $(IR)$  will both bind at the optimum. The optimal short-term performance contract solves the following program:

$$\begin{aligned} \max_{\alpha_H, \alpha_L, w_H, w_L} \quad & \mathbb{E} \pi_1 + P_1 (1 - \alpha_H) (\bar{a}_H - (\bar{a}_L + m)) \\ \text{s.t.} \quad & (P_1 - P_0) [(u(w_H) + \alpha_H u(b_H) + (1 - \alpha_H) u(b_L)) \\ & - (u(w_L) + \alpha_L u(b_H) + (1 - \alpha_L) u(b_L))] \geq \psi, \quad (IC) \\ & P_1 [u(w_H) + \alpha_H u(b_H) + (1 - \alpha_H) u(b_L)] + \\ & (1 - P_1) [u(w_L) + \alpha_L u(b_H) + (1 - \alpha_L) u(b_L)] \geq \psi. \quad (IR) \end{aligned}$$

Further, denote  $u_{2i}$  as the second-period expected utility of  $A$  when  $y_1 = y_i$ , i.e.,  $u_{2i} = \alpha_i u(b_H) + (1 - \alpha_i) u(b_L)$ ,  $i = L, H$ . For any given disclosure policy, the optimal wages are given by the following equations:

$$u(w_H^*) = \psi + \frac{(1 - P_1)\psi}{\Delta P} - u_{2H} \text{ and } u(w_L^*) = \psi - \frac{P_1\psi}{\Delta P} - u_{2L}.$$

The optimal disclosure policy now solves the following program:

$$(6) \quad \max_{\alpha_H, \alpha_L} \Pi = P_1 (y_H - w_H^*) + (1 - P_1) (y_L - w_L^*) + P_1 (1 - \alpha_H) (\bar{a}_H - (\bar{a}_L + m)).$$

For expositional purposes, I assume a specific form of  $u(x) = A - e^{-rx}$ ,  $r > 0$ . This functional form represents constant absolute risk aversion, captured by parameter  $r$ . The associated inverse function is  $h(u) = -\frac{1}{r} \ln(A - u)$ . Using this functional form and dropping the terms that do not involve  $\alpha_H$  or  $\alpha_L$ , one can rewrite (6) as:

$$(7) \quad \max_{\alpha_H, \alpha_L} \tilde{\Pi} = \frac{1}{r} \left[ P_1 \ln \left( A - \psi - \frac{(1-P_1)\psi}{\Delta P} + u_{2H} \right) + (1 - P_1) \ln \left( A - \psi + \frac{P_1\psi}{\Delta P} + u_{2L} \right) \right] + P_1 (1 - \alpha_H) (\bar{a}_H - (\bar{a}_L + m)).$$

Optimality of full transparency requires  $\delta^* = (\alpha_H = 1, \alpha_L = 0)$  to be a solution for (7). Hence, it must be true that  $\left( \partial \tilde{\Pi} / \partial \alpha_H \right)_{\delta=\delta^*} \geq 0$  and  $\left( \partial \tilde{\Pi} / \partial \alpha_L \right)_{\delta=\delta^*} \leq 0$ .<sup>12</sup> By differentiating  $\tilde{\Pi}$  w.r.t.  $\alpha_H$  and  $\alpha_L$  at  $\delta^*$ , one arrives at:<sup>13</sup>

$$\left. \frac{\partial \tilde{\Pi}}{\partial \alpha_H} \right|_{\delta=\delta^*} = \frac{P_1}{r (A - u(w_H^*))} \left. \frac{\partial u_{2H}}{\partial \alpha_H} \right|_{\delta=\delta^*} - P_1 (\bar{a}_H - (\bar{a}_L + m))$$

and

$$\left. \frac{\partial \tilde{\Pi}}{\partial \alpha_L} \right|_{\delta=\delta^*} = \frac{1}{r} \left[ \frac{P_1}{(A - u(w_H^*))} \left. \frac{\partial u_{2H}}{\partial \alpha_L} \right|_{\delta=\delta^*} + \frac{(1 - P_1)}{(A - u(w_L^*))} \left. \frac{\partial u_{2L}}{\partial \alpha_L} \right|_{\delta=\delta^*} \right],$$

where  $(\partial u_{2H} / \partial \alpha_H)_{\delta=\delta^*} > 0$ ,  $(\partial u_{2H} / \partial \alpha_L)_{\delta=\delta^*} < 0$  and  $(\partial u_{2L} / \partial \alpha_L)_{\delta=\delta^*} > 0$ . Hence, if  $r$  is high enough,  $\left( \partial \tilde{\Pi} / \partial \alpha_H \right)_{\delta=\delta^*} < 0$ . The more risk averse  $A$  is, the more difficult it is to sustain full disclosure. Moreover,  $\left( \partial \tilde{\Pi} / \partial \alpha_L \right)_{\delta=\delta^*} > 0$  or  $< 0$  depending on the relative magnitudes of  $(\partial u_{2H} / \partial \alpha_L)_{\delta=\delta^*}$  and  $(\partial u_{2L} / \partial \alpha_L)_{\delta=\delta^*}$ . Figure 3 shows a numerical example based on the above model specifications, where  $P_0 = 0.3$ ,  $m = 1$ ,  $\psi = 1$ ,  $\bar{P}_1 = 0.8$ ,  $\underline{P}_1 = 0.5$ ,  $p = 0.4$  and  $A = 2$ .

<sup>12</sup>At  $\delta = \delta^*$ , consider only the left-hand derivative, i.e.,  $\frac{\partial \tilde{\Pi}}{\partial \alpha_H} = \lim_{k \uparrow 0} \frac{\tilde{\Pi}(\alpha_H + k) - \tilde{\Pi}(\alpha_H)}{k}$ . This means that the value of the objective function may not increase as  $\alpha_H$  decreases. Similarly, consider only the right hand derivative for  $\frac{\partial \tilde{\Pi}}{\partial \alpha_L}$ .

<sup>13</sup>Recall that  $b_L = \bar{a}_L + m$  for all sufficiently small deviations from full transparency. Therefore,  $\frac{\partial b_L}{\partial \alpha_H} = \frac{\partial \bar{a}_L}{\partial \alpha_H} = 0$  at full transparency.

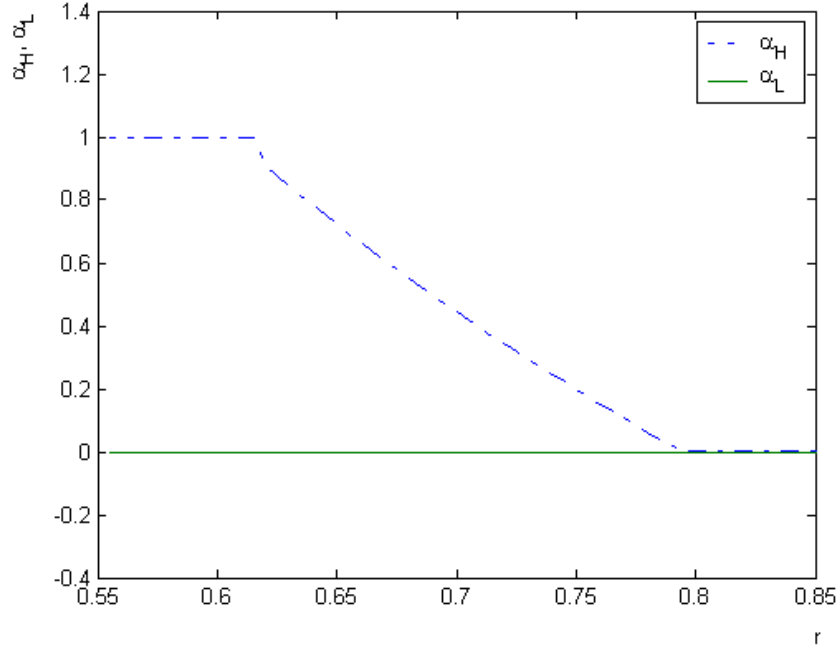


Figure 3. Disclosure Policy for a Risk Averse Agent

It is important to note that the trade off between matching efficiency and risk, that arises in the context of short-term contract, only depends on extent to which short-term contracts can substitute risk intertemporally. In fact, when  $A$ 's period-one and period-two incomes are perfect substitutes, a short-term contract can completely offset the additional human capital risk. Therefore risk neutrality of  $A$  is no longer necessary to ensure full transparency under short-term performance contracts when the raider's market is perfectly competitive. Proposition 6 establishes this observation.

**Proposition 6.** *If  $A$  is risk averse, the optimal short-term contract for  $F$  induces full transparency if  $u(t_1, t_2) = u(t_1 + t_2)$ .*

*Proof.* See Appendix A. ■

When the agent's utility of the agent depends on the aggregate net transfer in the two periods, a short-term performance contract can countervail any fluctuation in  $t_2$  by adjusting  $t_1$  and keeping the aggregate payoff unchanged.

## 6. EXTENSIONS AND DISCUSSION

This section discusses the robustness of my results to some of the simplifying assumptions of the model. First, I prove that my benchmark results can be extended to the case of continuum types. Second, I show that they hold true even in an environment where the



matching factor,  $m$ , depends on ability, and the turnover for certain types is not efficient. Finally, I briefly discuss the role of output's informativeness the agent's ability and labor market implications of optimal disclosure policy.

**6.1. Continuum of Types.** Consider the following changes in the model described in Section 3. Let  $a \in A = [\underline{a}, \bar{a}] \subset \mathbb{R}$ ,  $y_1 \in Y = [\underline{y}, \bar{y}] \subset \mathbb{R}_+$  and  $e \in [0, 1]$ . Given  $e$ , let the joint distribution function of  $a$  and  $y_1$  be  $F(a, y_1; e)$ , with density  $f(a, y_1; e)$  having full support over the domain  $A \times Y$ . For clarity of notation, I shall suppress  $e$  in  $F$  and  $f$  unless the exact value of  $e$  is of particular relevance. With an abuse of notation, define  $f(a)$  and  $f(y_1)$  as the respective marginal distributions, and  $f(a | y_1)$  and  $f(y_1 | a)$  as the respective conditional distributions. I assume that  $\mathbb{E}(a | y_1)$  exists  $\forall y_1 \in Y$ , continuous, and  $\partial \mathbb{E}(a | y_1) / \partial y_1 > 0$ . Moreover, analogous to Assumption 1, let  $E(a | \bar{y}) - E(a | \underline{y}) > m$ . The cost of the effort is  $\psi(e)$ , which is increasing and convex in  $e$ . I maintain all the other assumptions of the original model.

In such an environment, the raider's bidding function is:

$$b(x) = \begin{cases} \mathbb{E}(a | x) + m & \text{if } \mathbb{E}(a | x) + m > \mathbb{E}(a | \bar{y}) \\ b^*(x) & \text{otherwise} \end{cases},$$

where  $b^*(x)$  solves the following equation:

$$(8) \quad b^*(x) = \mathbb{E}_{y_1} [\mathbb{E}_a [a | x, y_1, \mathbb{E}(a | y_1) < b^*(x)] | x] + m.$$

The logic is similar to the one used in Lemma 1. The raiders bid the agent's expected productivity conditional on the signal and the turnover pattern that such a bid will induce. As already mentioned, if  $\mathbb{E}(a | x) + m \leq \mathbb{E}(a | \bar{y})$ , then by bidding the agent's expected productivity,  $\mathbb{E}(a | x) + m$ , the raider will face an adverse selection problem. The raiders will take this into account and condition their expectations on not only the signal  $x$ , but also on the fact that an agent with type  $\mathbb{E}(a | y_1)$  switches his employer if and only if  $\mathbb{E}(a | y_1) < b^*(x)$ .

Equation (8) suggests that, as in the binary-type case, with the continuum of types, trade is inefficient under partial disclosure. When  $\mathbb{E}(a | x) + m \leq \mathbb{E}(a | \bar{y})$ , an agent of type  $\mathbb{E}(a | y_1)$  is retained by  $F$  when  $\mathbb{E}(a | y_1) < b^*(x)$ . The intuition behind Proposition 1 can, therefore, be carried forward to this case as well. In Appendix B, I prove Proposition 1 with a continuum of types. The proof for Proposition 2 is similar and is omitted here.

**6.2. Ability-Dependent Matching Factor.** Thus far, I have assumed that the gains from matching,  $m$ , are independent of ability levels and a turnover is efficient for all types. Instead, one may assume that the matching factor can be negative or positive depending on the ability level, i.e.,  $m = m(a)$  and  $m(\underline{a}) < 0 < m(\bar{a})$ . In the initial model, I argued that the trade volume may be too low under a partial disclosure policy. In the current scenario, partial disclosure can also lead to too much trade. If  $m(\underline{a})$  is a sufficiently large negative number

compared to  $m(\bar{a})$ , then  $\mathbb{E}(m(a) | y_L) < 0 < \mathbb{E}(m(a) | y_H)$ . At the first best level of trade, only the high-type should switch to the raider's firm. The raider's bidding function is:

$$b(x) = \begin{cases} \mathbb{E}(a + m(a) | x) & \text{if } \mathbb{E}(a + m(a) | x) > \mathbb{E}(a | y_H) \\ \mathbb{E}(a + m(a) | y_L) & \text{otherwise} \end{cases}.$$

As before, under a partial disclosure policy, following  $y_1 = y_H$ , the trade volume can be too low due to the winner's curse effect. On the other hand, however, following  $y_1 = y_L$ , the trade volume can be too high, as for some signals both types may leave for the raider's firm. This observation, again, calls for full transparency to maximize the trading surplus. The benchmark results in this paper are therefore robust to such modification. The rigorous proof of this claim is provided in Appendix B.<sup>14</sup>

**6.3. On Informativeness of Output.** Assumption 1 requires  $\bar{a}_H - \bar{a}_L > m$ . The difference  $\bar{a}_H - \bar{a}_L$ , or the strength of the career concern based incentive, reflects the informativeness of output about the agent's ability. Thus, the less informative the output is with respect to  $A$ 's ability, the more difficult it is to satisfy this assumption. The winner's curse problem may disappear if the output is not very informative, as Assumption 1 is no longer satisfied. In that case, any arbitrary disclosure policy ensures efficient trade and hence, the same profit for  $F$ .

When  $A$  faces a liquidity constraint and only short-term performance contracts are feasible, the output's informativeness plays an important role. Recall that, in such an environment, full transparency is ensured if such a disclosure policy fails to satisfy the *(IC)* or *(IR)* constraint of  $A$  in when wages in period-one are set at zero (see equation (5')). When  $\bar{a}_H - \bar{a}_L$  is small, it is easier to satisfy (5'). Hence, as the output's informativeness decreases, it is more likely that the optimal short-term performance contract will induce full transparency even in the presence of liquidity constraints on  $A$ .

It is also worth mentioning that, when  $A$  is risk averse, a decrease in the output's informativeness reduces the amount of additional human capital risk premium associated with full disclosure. When  $\bar{a}_H - \bar{a}_L$  is small,  $A$  only faces a minor fluctuation in his period-two income. Therefore, it is more likely that full disclosure will be optimum even in the presence of risk aversion.

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<sup>14</sup>In a similar fashion, one can assume  $m(\underline{a}) > 0 > m(\bar{a})$ , which may imply  $\mathbb{E}(m(a) | y_L) > 0 > \mathbb{E}(m(a) | y_H)$ . If  $\bar{a}_L < \mathbb{E}(a + m(a) | y_L) < \mathbb{E}(a + m(a) | y_H) < \bar{a}_H$ , then  $b(x) = \mathbb{E}(a + m(a) | y_L) \forall x$  and trade is always at its optimal volume irrespective of the disclosure policy. However, if  $\bar{a}_H < \mathbb{E}(a + m(a) | y_L)$ , then a partial disclosure policy can again lead to a more-than-sufficient trade volume where a high-type agent may switch jobs with a positive probability. Similarly, if  $\mathbb{E}(a + m(a) | y_H) < \bar{a}_L$ , the trade volume may be too low as the low-type agent may not be traded.

**6.4. Labor Market Implications.** Partial disclosure as an optimal policy may have severe implications on promotion rules and job design, which often serve the purpose of information disclosure by changing the visibility of the worker's performance to the outside market. Consider the case of a monopsonist raider. In Section 5.1, I argue that the optimal policy requires pooling the low-type agent with the high-type with suitable probability. This may correspond to a promotion rule, according to which an incompetent worker is sometimes promoted only to lure the raider into bidding a high value for him. This contrasts the result shown by Waldman (1984), where promotion is often denied even to a competent worker. He argues that promotion is a signal of high ability and, therefore, raises the market wage of the worker, making retention costly for the firm. However, a similar argument holds when the agent faces a liquidity constraint. As the optimal disclosure policy may involve mixing the high-type agent with the low-type, such policy may result in too few promotion offers. Strategic job design can also lead to a specific disclosure pattern. The case of HCL America, as mentioned in the introduction, is a typical example.

The model discussed here is particularly relevant for temporary help supply (THS) firms and firms in consulting and software industries. Most of the THS firms train their workers in general skills (Autor, 2001). Young workers in these firms often take their employment as an investment in skill acquisition (accepting a wage lower than the one they can earn in THS firms that do not offer training) and later leave for a permanent job where the acquired skills are more useful. In consulting or software firms, the workers are often required to acquire specific skills in order to serve their clients. The client firms can often more efficiently provide incentives for specific skill acquisition. Mukherjee (2003) shows that, if skill acquisition is perfectly observed by all parties, efficiency is enhanced when implicit incentives through a relational contract are used along with explicit ones. A specific skill acquired for a client's job is often not observable to the employer. However, if the worker switches jobs to join the client's firm, she can reward the worker through a relational contract, which increases the worker's productivity through better skill acquisition. Hence, it is more likely that the worker will be a better match for the client. This may explain why the clients are often the raiders in consulting and software firms. Moreover, when the client firm tries to raid workers, it enjoys a monopsony power. Therefore, my model predicts that these firms will resort to a partial disclosure policy. This is also reflected in the HCL America case.

## 7. CONCLUSION

This paper presents a model of sequential contracting in labor markets where the initial employer has better information than the prospective employers about the worker. When the worker cares about his reputation, and matching between the worker and the firm affects productivity, there is a scope for the initial employer to increase her payoff through strategic information disclosure. The paper provides a characterization of the optimal disclosure policy in such an environment.

If the initial employer can write a long-term complete contract, then competition in the raider market ensures full disclosure. When long-term contracts are infeasible, the firm can restrict itself to short-term performance contracts with full disclosure when i) the worker is risk neutral, ii) the worker faces no liquidity constraint, and iii) the raider market is perfectly competitive. These sufficient conditions for full disclosure are also “almost” necessary in the sense that, if any of them is relaxed, one can find preferences for the worker and the parameter values for which full disclosure is not optimal.

The trade-offs emphasized in this paper are not necessarily the only factors that determine a firm’s disclosure policy. Harris and Holmstrom (1982) show that, when the market learns about the worker’s ability over time, the optimal wage contract is downward rigid. To retain the worker, the firm is forced to raise the wage after every good performance. In such a set up, the strategic disclosure of a worker’s performance may increase the firm’s profit by allowing for more flexibility in the wage setting. The disclosure of performance may also influence the firm’s ability to enforce implicit contracts. The implications of a disclosure policy in a repeated interaction model offer an interesting direction for future research.

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## APPENDIX A: PROOFS OMITTED IN THE TEXT

**Proof of Lemma 1:** Observe that  $b_1(x) = b_2(x)$  as raiders compete in their bids to win the agent.

First consider the case of long-term complete contract. I derive the bidding function in following steps.

**Step 1.** Let  $b(x) = b$ . Further suppose that the final offer from  $F$ , upon observing  $b$ , is  $(\hat{w}_2, \hat{s})$ . In any equilibrium where  $A$  stays with  $F$ , iff  $\hat{w}_2 \geq b + \hat{s}$ , or

$$(9) \quad \hat{w}_2 - \hat{s} \geq b.$$

Moreover,  $F$  prefers to retain the agent with  $y_1 = y_i$  ( $i = L, H$ ) by choosing an appropriate  $(\hat{w}_2, \hat{s})$  pair iff  $\bar{a}_i - \hat{w}_2 \geq -\hat{s}$  or

$$(10) \quad \bar{a}_i \geq \hat{w}_2 - \hat{s}.$$

**Step 2.** (9) and (10) imply that there is turnover with  $y_1 = y_i$  if and only if  $\bar{a}_i < b$ .

The proof of the “if” part directly follows from equations (9) and (10). When there is no turnover, equations (9) and (10) must hold. Together, they imply  $\bar{a}_i \geq b$ . Hence, if  $\bar{a}_i < b$  then there is turnover.

To prove the “only if” part, I shall argue that if  $\bar{a}_i \geq b$  then there is no turnover. Let the initial offer be  $(w_2, s)$ . If  $\bar{a}_i \geq w_2 - s \geq b$  then both  $F$  and  $A$  would prefer to continue the employment relationship leading to no turnover.

When  $\bar{a}_i \geq b > w_2 - s$ ,  $A$  prefers to leave at the current wages while  $F$  would like to keep him.  $F$  would offer  $\hat{w}_2 > w_2$  such that  $\hat{w}_2 - s = b$ . At the offer  $(\hat{w}_2, s)$ ,  $A$  would stay and  $F$  would still prefer that to letting him go as  $\bar{a}_i - \hat{w}_2 \geq -s$  when  $\bar{a}_i \geq b$ .

Finally, if  $w_2 - s > \bar{a}_i \geq b$ ,  $A$  prefers to stay while  $F$  makes a loss on him. But it will not be viable for  $F$  to make  $A$  leave.  $A$  leaves only if  $F$  raises  $s$  to  $\hat{s}$  such that  $w_2 - \hat{s} < b$ . So it must be the case that  $\bar{a}_i - w_2 > -\hat{s}$ . Hence  $F$  is better off by keeping  $A$  than to pay him to leave.

**Step 3.** Observe that for any  $x$ , bidding in the interval  $(\bar{a}_L, \bar{a}_H]$  is dominated by bidding  $\bar{a}_L + m$ . If the raiders are bidding in the interval  $(\bar{a}_L, \bar{a}_H]$  they are sure to get the low-type agent. If  $\bar{a}_L < b < \bar{a}_H$ , by step 2,  $F$  will let the low-type agent quit while retaining the high-type agent. Therefore, competition ensures that raider’s will bid  $\bar{a}_L + m$ . They are necessarily overbidding if they bid in the interval  $(\bar{a}_L + m, \bar{a}_H]$  and they will not win the agent if their bid is in the interval  $(\bar{a}_L, \bar{a}_L + m)$ .

**Step 4.** Bidding in the interval  $(\bar{a}_H, \infty)$  ensures that the agent will work for the raiders irrespective of his types (here  $\bar{a}_i < b$  where  $i = H, L$ ). Therefore the expected productivity

of the agent when the bid is in the interval  $(\bar{a}_H, \infty)$  is  $\mathbb{E}(a | x) + m$ . Hence, raiders will bid  $\mathbb{E}(a | x) + m$  only if  $\mathbb{E}(a | x) + m > \bar{a}_H$ .

Combining these observations I get equation (2).

Next, I consider the case of short-term performance contracts. Recall that a short-term performance contract is a special case of long-term complete contracts where  $w_2 = s = 0$ . Under the short-term performance contract, in period-two,  $F$  solves

$$\max_{\hat{w}_2 \geq 0} \mathbb{E}_{y_2|y_1} (y_2 - \hat{w}_2) \mathbb{I}\{\hat{w}_2 \geq \max\{b_1, b_2\}\}.$$

Hence,  $F$  will match the highest bid as long as the bid is less than the type of the agent. So for any  $b < \bar{a}_H$ ,  $F$  will match the bid only for the high-type agent. This implies equation (2) by steps 3 and 4. ■

**Proof of Proposition 1: Step 1.** Consider a candidate equilibrium  $\mathcal{E}$  associated with the program  $\mathcal{P}$ . Let  $\delta$  be the associated disclosure policy and  $\exists x_k, x_l \in X(\delta)$  such that  $0 < \delta(x_k | y) \delta(x_l | y) < 1$  for some  $y \in \{y_L, y_H\}$ .

Let  $X_H = \{x \in X(\delta) \mid b(x) \geq \bar{a}_H\}$ , i.e., the set of signals for which the raider's bid is greater than the valuation of the highest possible type. Further define  $X_L = X \setminus X_H$ . From (2), I claim that  $\forall x \in X_H$  there is turnover and for  $x \in X_L$ , there is turnover iff  $y = y_L$ . Therefore, the profit to  $F$  in  $\mathcal{E}$  is

$$\begin{aligned} \Pi = & P_1(y_H - \mathbb{E}(w_1 | y_H)) + (1 - P_1)(y_L - \mathbb{E}(w_1 | y_L)) + \\ & P_1 \left( - \int_{X_H} \hat{s}(x, y_H) \delta(x | y_H) dx + \int_{X_L} (\bar{a}_H - \hat{w}_2(y_H, x)) \delta(x | y_H) dx \right) \\ & - (1 - P_1) \int_X \hat{s}(x, y_L) \delta(x | y_L) dx. \end{aligned}$$

(Recall that a long-term complete contract allows for randomization in wages in the first-period.)

**Step 2.** Consider another candidate equilibrium  $\mathcal{E}^*$  defined as follows: Let the associated disclosure policy be fully transparent. In addition, suppose that  $F$  also generates another signal  $x \in X$  according to the disclosure policy  $\delta$ . The period-two wages and severance payments of  $A$ ,  $(w_2^*, s^*)$ , are based on the realized  $x$  values. Let  $w_1$  be unchanged from the initial contract and set  $w_2^* = s^* = \hat{w}_2^* = \hat{s}^*$  where  $\hat{s}^*$  is given by the equation

$$(11) \quad b(y_1) + \hat{s}^*(x, y_1) = \max\{b(x) + \hat{s}(x, y_1), \hat{w}_2(x, y_1)\} \quad \forall x \in X \text{ and } y_1 \in Y,$$

where  $b(y_1) = \mathbb{E}(a | y_1) + m$ , the bid of the raiders when  $y_1$  is directly revealed under full transparency. By construction, facing this contract  $A$  will choose the same effort level and receive the same expected utility as in the initial contract given in  $\mathcal{E}$ .



**Step 3.** Under the new contract, following  $y_1 = y_i$ ,  $F$ 's profit will be

$$(12) \quad \Pi_i^* = y_i - \mathbb{E}(w_1 | y_i) - \int_X \hat{s}^*(x, y_i) \delta(x | y_i) dx \quad i = L, H.$$

Note that (11) implies

$$(13) \quad \begin{aligned} & \bar{a}_H + m + \int_X \hat{s}^*(x, y_H) \delta(x | y_H) dx = \\ & \int_{X_H} (b(x) + \hat{s}(x, y_H)) \delta(x | y_H) dx + \int_{X_L} \hat{w}_2(x, y_H) \delta(x | y_H) dx \end{aligned}$$

and

$$(14) \quad \bar{a}_L + m + \int_X \hat{s}^*(x, y_L) \delta(x | y_L) dx = \int_X (b(x) + \hat{s}(x, y_L)) \delta(x | y_L) dx.$$

It remains to show that  $F$ 's profit under the new contract,  $\Pi^* = P_1 \Pi_H^* + (1 - P_1) \Pi_L^* \geq \Pi$ .

**Step 4.** Using (13) and (14), I claim

$$\begin{aligned} \Pi^* &= P_1 \Pi_H^* + (1 - P_1) \Pi_L^* \\ &\geq P_1 (y_H - \mathbb{E}(w_1 | y_H)) + (1 - P_1) (y_L - \mathbb{E}(w_1 | y_L)) + \\ &\quad P_1 \left[ \bar{a}_H + m - \int_{X_H} (b(x) + \hat{s}(x, y_H)) \delta(x | y_H) dx + \right. \\ &\quad \left. \int_{X_L} (\bar{a}_H - \hat{w}_2(x, y_H)) \delta(x | y_H) dx - \int_{X_L} (\bar{a}_H + m) \delta(x | y_H) dx \right] + \\ &\quad (1 - P_1) \left[ \bar{a}_L + m - \int_X (b(x) + \hat{s}(x, y_L)) \delta(x | y_L) dx \right], \end{aligned}$$

as  $m \int_{X_L} \delta(x | y_H) dx \geq 0$ . Using the fact that  $P_1 \bar{a}_H + (1 - P_1) \bar{a}_L = \mathbb{E}(a)$ , one can rewrite the above expression as

$$\begin{aligned} \Pi^* &\geq \Pi + \mathbb{E}(a) + m - \\ &\quad P_1 \left[ \int_{X_H} b(x) + \int_{X_L} (\bar{a}_H + m) \right] \delta(x | y_H) dx - (1 - P_1) \int_X b(x) \delta(x | y_L) dx. \end{aligned}$$

Hence, to prove  $\Pi^* \geq \Pi$  it is enough to show that

$$(15) \quad \begin{aligned} & \mathbb{E}(a) + m \geq \\ & P_1 \left[ \int_{X_H} b(x) \delta(x | y_H) dx + \int_{X_L} (\bar{a}_H + m) \delta(x | y_H) dx \right] + (1 - P_1) \int_X b(x) \delta(x | y_L) dx. \end{aligned}$$

**Step 5.** The right hand side of (15) can be written as

$$\begin{aligned} & \int_{X_H} b(x) [P_1 \delta(x | y_H) + (1 - P_1) \delta(x | y_L)] dx + \\ & P_1 \int_{X_L} (\bar{a}_H + m) \delta(x | y_H) dx + (1 - P_1) \int_{X_L} (\bar{a}_L + m) \delta(x | y_L) dx. \end{aligned}$$

Now,

$$\begin{aligned} & \int_{X_H} b(x) [P_1 \delta(x | y_H) + (1 - P_1) \delta(x | y_L)] dx = \int_{X_H} b(x) \delta(x) dx \\ & = \int_{X_H} (\mathbb{E}(a | x) + m) \delta(x) dx \end{aligned}$$

(where  $\delta(x)$  is the total probability of receiving the signal  $x$  under the disclosure policy  $\delta$ ) and

$$\begin{aligned} & P_1 \int_{X_L} (\bar{a}_H + m) \delta(x | y_H) dx + (1 - P_1) \int_{X_L} (\bar{a}_L + m) \delta(x | y_L) dx \\ & = \int_{X_L} \left[ (\bar{a}_H + m) \frac{P_1 \delta(x | y_H)}{\delta(x)} + (\bar{a}_L + m) \frac{(1 - P_1) \delta(x | y_L)}{\delta(x)} \right] \delta(x) dx \\ & = \int_{X_L} [(\bar{a}_H + m) \Pr(y_H | x) + (\bar{a}_L + m) \Pr(y_L | x)] \delta(x) dx \\ & = \int_{X_L} \left[ \sum_{y_1} \mathbb{E}(a | x, y_1) \Pr(y_1 | x) + m \right] \delta(x) dx \\ & = \int_{X_L} (\mathbb{E}(a | x) + m) \delta(x) dx. \end{aligned}$$

So, the right hand side of (15) is equal to

$$\int_{X_H} (\mathbb{E}(a | x) + m) \delta(x) dx + \int_{X_L} (\mathbb{E}(a | x) + m) \delta(x) dx = \mathbb{E}(a) + m.$$

Hence, the condition (15) holds with equality. Note that  $\Pi^* > \Pi$  if  $\int_{X_L} \delta(x | y_H) dx > 0$ , i.e., if under  $\delta$  the high-type agent faces a bid equal to  $\bar{a}_L + m$  with nonzero probability. ■

**Proof of Proposition 2:** Recall that short-term performance contract is a special case of long-term complete contract. Hence, it is enough to show that under condition *i)-iii)*, the optimal short-term performance contract with full transparency yields the same profit to  $F$  as the optimal long-term complete contract.

**Step 1.** Proposition 1 suggests that the optimal long-term complete contract induces full transparency under a perfectly competitive raider market. The profit to  $F$  under this contract is

$$(16) \quad \Pi^L = \mathbb{E}_{y_1} \left[ y_1 - w_1(y_1) - \int_X \hat{s}(x, y_1) \delta(x | y_1) dx \right].$$

When  $A$  is risk neutral, under the optimal long-term contract, the *(IR)* constraint of  $A$  implies

$$\mathbb{E}_{y_1} \left[ (\bar{a}_i + m) + w_1(y_1) + \int_X \hat{s}(x, y_1) \delta(x | y_1) dx \right] = \psi.$$

Hence, (16) can be written as  $\Pi^L = \mathbb{E} y_1 - (\psi - (\mathbb{E}(a) + m))$ .

**Step 2.** Consider the short-term performance contract with full transparency where the first-period wage  $w_1^*(y_1)$  is given as

$$\begin{aligned} w_1^*(y_H) &= \psi + \frac{(1-P_1)\psi}{\Delta P} - (\bar{a}_H + m), \\ w_1^*(y_L) &= \psi - \frac{P_1\psi}{\Delta P} - (\bar{a}_L + m), \end{aligned}$$

and the second-period wage  $\hat{w}_2^* = 0$ . These wage payments are feasible as  $A$  does not face any liquidity constraint. By construction,  $(IC)$  and  $(IR)$  constraint of  $A$  will bind. Hence, under this contract,  $A$  faces the same incentives and earns the same rent as in the case of the optimal long-term complete contract. Finally, observe that  $F$ 's profit under this contract is

$$\Pi^S = \mathbb{E}_{y_1} [y_1 - w_1^*(y_1)] = \mathbb{E} y_1 - (\psi - (\mathbb{E}(a) + m)) = \Pi^L.$$

■

**Proof of Proposition 3:** This proof uses the same technique as the proof of Proposition 1.

**Step1.** Recall that under the policy  $\delta^{PD}$  the profit to  $F$  is

$$\begin{aligned} \Pi &= P_1 (y_H - w_1(y_H)) + (1 - P_1) (y_L - w_1(y_L)) + \\ &P_1 \left( - \int_{X_H} \hat{s}(x, y_H) + \int_{X_L} (\bar{a}_H - \hat{w}_2(x, y_H)) \right) \delta^{PD}(x | y_H) dx - \\ &(1 - P_1) \int_X \hat{s}(x, y_L) \delta^{PD}(x | y_L) dx, \end{aligned}$$

where  $X_H = \{x \in X(\delta^{PD}) \mid b(x) \geq \bar{a}_H\}$  and  $X_L = X \setminus X_H$ . Consider another candidate solution to  $\mathcal{P}$  where  $F$  does not disclose any information. Hence, raiders will bid  $\mathbb{E}(a) + m$  for both the types as  $\mathbb{E}(a) + m > \bar{a}_H$ . In addition,  $F$  also generates a signal  $x \in X$  (not revealed to the raiders) according to the disclosure policy  $\delta^{PD}$ . The period-two wages and severance payments of  $A$ ,  $(w'_2, s')$ , are based on the realized  $x$  values. Let  $w_1$  be unchanged from the initial contract and set  $w'_2 = s' = \hat{w}'_2 = \hat{s}'$  where  $\hat{s}'$  is given by equation (17), i.e.,

$$(17) \quad \mathbb{E}(a) + m + \hat{s}'(x, y_1) = \max \{b(x) + \hat{s}(x, y_1), \hat{w}_2(x, y_1)\} \quad \forall x \in X \text{ and } y_1 \in Y.$$

By construction, facing this contract  $A$  will choose the same effort level and receive the same expected utility as in the initial contract.

**Step 2.** Under the new contract, following  $y_1 = y_i$ ,  $F$ 's profit will be

$$(18) \quad \Pi_i^* = y_i - w_1(y_i) - \int_X \hat{s}'(x, y_i) \delta(x | y_i) dx \quad i = L, H.$$

Equation (17) implies

$$(19) \quad \mathbb{E}(a) + m + \int_X \hat{s}'(x, y_H) \delta(x | y_H) dx = \int_{X_H} (b(x) + \hat{s}(x, y_H)) \delta(x | y_H) dx + \int_{X_L} \hat{w}_2(x, y_H) \delta(x | y_H) dx$$

and

$$(20) \quad \mathbb{E}(a) + m + \int_X \hat{s}'(x, y_L) \delta(x | y_L) dx = \int_X (b(x) + \hat{s}(x, y_L)) \delta(x | y_L) dx.$$

It remains to show that  $F$ 's profit under the new contract,  $\Pi^* = P_1 \Pi_H^* + (1 - P_1) \Pi_L^* \geq \Pi$ .

**Step 3.** By arguments identical to Step 4 in the proof of Proposition 1, I claim that  $\Pi^* \geq \Pi$  iff

$$\mathbb{E}(a) + m \geq P_1 \left[ \int_{X_H} b(x) \delta^{PD}(x | y_H) dx + \int_{X_L} (\bar{a}_H + m) \delta^{PD}(x | y_H) dx \right] + (1 - P_1) \int_X b(x) \delta^{PD}(x | y_L) dx.$$

But Step 5 of the same proof shows that (by replacing  $\delta$  by  $\delta^{PD}$ )

$$\mathbb{E}(a) + m = P_1 \left[ \int_{X_H} b(x) \delta^{PD}(x | y_H) dx + \int_{X_L} (\bar{a}_H + m) \delta^{PD}(x | y_H) dx \right] + (1 - P_1) \int_X b(x) \delta^{PD}(x | y_L) dx.$$

Hence  $\Pi^* \geq \Pi$ . ■

**Proof of Proposition 4:** CASE A: SHORT-TERM PERFORMANCE CONTRACTS:

The first part of the proposition can be proved in the following way.

Consider a optimal short-term performance contract that discloses information using the policy  $\delta = (\alpha_H, \alpha_L)$ . Without loss of generality assume that  $\delta$  is such that  $\bar{a}_L = b(x_L) < b(x_H) = \bar{a}_H$ . Let the first-period wage be  $w_1(y_1)$  and as  $b(x_L) = \bar{a}_L$ , optimality requires  $\hat{w}_2(x_L, y_H) = \bar{a}_L$ . The profit to  $F$  under this contract is

$$\Pi = \mathbb{E}(y_1 - w_1(y_1)) + P_1 (\bar{a}_H - \bar{a}_L) (1 - \alpha_H).$$

Consider another short-term performance contract where no information is disclosed, i.e., signals are pure noise. Hence under this contract  $\mathbb{E}(a | x) = \mathbb{E}(a) \forall x \in \{x_L, x_H\}$ . As  $\mathbb{E}(a) > \bar{a}_H - P_1 m$ , upon receiving any signal,  $b = \bar{a}_H$ . Let  $w_1^*(y_1)$  be the first-period wages given by (21)

$$(21) \quad \begin{aligned} \bar{a}_H + w_1^*(y_H) &= w_1(y_H) + \bar{a}_H \alpha_H + \bar{a}_L (1 - \alpha_H), \\ \bar{a}_H + w_1^*(y_L) &= w_1(y_L) + \bar{a}_H \alpha_L + \bar{a}_L (1 - \alpha_L). \end{aligned}$$

By construction, this contract leaves agent's incentives and expected utility unaltered compared to the initial case. As there is turnover for all types of the agent, with an abuse of notation,  $F$ 's profit under this contract is

$$\Pi^* = \mathbb{E}(y_1 - w_1^*(y_1)).$$

I claim  $\Pi^* \geq \Pi$ . To see this, note that

$$\Pi^* \geq \Pi \Leftrightarrow \mathbb{E}(w_1(y_1) - w_1^*(y_1)) \geq P_1(\bar{a}_H - \bar{a}_L)(1 - \alpha_H).$$

But (21) implies

$$\begin{aligned} \mathbb{E}(w_1(y_1) - w_1^*(y_1)) &= (\bar{a}_H - \bar{a}_L)[P_1(1 - \alpha_H) + (1 - P_1)(1 - \alpha_L)] \\ &> P_1(\bar{a}_H - \bar{a}_L)(1 - \alpha_H). \end{aligned}$$

Hence the proof.

To prove the second part I proceed as follows.

**Step 1.** If  $\mathbb{E}(a) < \bar{a}_H - P_1m$  then under any disclosure policy  $\delta$  it is never the case that  $b(x_L) = b(x_H) = \bar{a}_H$ . If  $\mathbb{E}(a | x) > \bar{a}_H - P_1m \forall x \in \{x_L, x_H\}$  then it must be the case that  $\mathbb{E}(a) > \bar{a}_H - P_1m$ ; a contradiction. Without loss of generality I assume that  $\bar{a}_L = b(x_L) \leq b(x_H)$ .

**Step 2.** Consider the disclosure policy  $\delta^*$  where  $\alpha_H = 1$  and  $\alpha_L = \alpha_L^*$  such that the following equation is satisfied:

$$(22) \quad \mathbb{E}(a | x_H) = \bar{a}_H - P_1m.$$

Note that  $\alpha_L^* > 0$  and there is turnover for both types. I claim that  $\delta^*$  is the optimal disclosure policy.

**Step 3.** Given any disclosure policy  $\hat{\delta} = (\hat{\alpha}_H, \hat{\alpha}_L) (\neq \delta^*)$ ,  $\delta^*$  yields a higher payoff to the firm. The argument is as follows. It is already noted that under  $\hat{\delta}$ , either  $b(x_L) = b(x_H) = \bar{a}_L$  or  $\bar{a}_L = b(x_L) < b(x_H) = \bar{a}_H$ . I shall consider the case where  $b(x_L) < b(x_H)$ . The argument for the other case is similar.

Consider the optimal short-term performance contract with disclosure policy  $\hat{\delta}$ . Let the associated first-period wages be  $w_1(y_1)$ . By virtue of optimality of the contract and the bids of the raiders,  $\hat{w}_2(x_L, y_H) = \bar{a}_L$ . The profit to  $F$  under this contract is

$$\hat{\Pi} = \mathbb{E}(y_1 - w_1(y_1)) + P_1(\bar{a}_H - \bar{a}_L)(1 - \hat{\alpha}_H).$$

I replace the above contract by another one with the disclosure policy  $\delta^*$  and the first-period wage  $w_1^*(y_1)$  is given by (23)

$$(23) \quad \begin{aligned} \bar{a}_H + w_1^*(y_H) &= w_1(y_H) + \hat{\alpha}_H \bar{a}_H + (1 - \hat{\alpha}_H) \bar{a}_L, \\ \alpha_L^* \bar{a}_H + (1 - \alpha_L^*) \bar{a}_L + w_1^*(y_L) &= w_1(y_L) + \hat{\alpha}_L \bar{a}_H + (1 - \hat{\alpha}_L) \bar{a}_L. \end{aligned}$$

Again, by construction, the agent's payoff is the same conditional on the realized output. Hence at the new disclosure policy along with the wages  $w_1^*(y_1)$ , the (IC) and (IR) constraints are satisfied. The profit of the firm under the new contract (again, with an abuse of notation) is

$$\Pi^* = \mathbb{E}(y_1 - w_1^*(y_1)).$$

**Step 4.** First, note that  $\alpha_L^* \geq \hat{\alpha}_L$ . The argument is the following.<sup>15</sup> By definition,

$$\mathbb{E}_\delta(a \mid x_H) \geq \mathbb{E}_{\delta^*}(a \mid x_H) = \bar{a}_H - P_1 m,$$

or,

$$\bar{a} \mu_\delta(\bar{a} \mid x_H) + \underline{a} \mu_\delta(\underline{a} \mid x_H) \geq \bar{a} \mu_{\delta^*}(\bar{a} \mid x_H) + \underline{a} \mu_{\delta^*}(\underline{a} \mid x_H),$$

or, (using the fact  $\mu_\delta(\bar{a} \mid x_H) = 1 - \mu_\delta(\underline{a} \mid x_H)$ )

$$(24) \quad \mu_\delta(\bar{a} \mid x_H) \geq \mu_{\delta^*}(\bar{a} \mid x_H)$$

As  $\mu(\bar{a} \mid x_H)$  is increasing in  $\alpha_H$  and decreasing in  $\alpha_L$ , from (24) it follows that  $\alpha_L^* \geq \hat{\alpha}_L$  as  $\alpha_H = 1$  in  $\delta^*$ .

**Step 5.** Finally,  $\Pi^* \geq \Pi$ . Note that

$$\Pi^* \geq \hat{\Pi} \Leftrightarrow \mathbb{E}(w_1(y_1) - w_1^*(y_1)) \geq P_1(\bar{a}_H - \bar{a}_L)(1 - \hat{\alpha}_H).$$

Now, by (23)

$$\begin{aligned} \mathbb{E}(w_1(y_1) - w_1^*(y_1)) &= (\bar{a}_H - \bar{a}_L) [P_1(1 - \hat{\alpha}_H) + (1 - P_1)(\alpha_L^* - \hat{\alpha}_L)] \\ &> P_1(\bar{a}_H - \bar{a}_L)(1 - \hat{\alpha}_H). \end{aligned}$$

The last inequality follows from the fact that  $\alpha_L^* > \hat{\alpha}_L$ .

CASE B: LONG-TERM COMPLETE CONTRACTS:

<sup>15</sup>I define  $\mathbb{E}_\delta$  as the expectation operator when the disclosure policy is  $\delta$ ; similarly for  $\mu_\delta$ .

As this proof is similar to the former one, I shall only provide a sketch here.

Consider the case  $\mathbb{E}(a) > \bar{a}_H - P_1 m$ . Given any candidate solution to the optimal long-term contracting problem, I propose the following contract: I keep the first-period wage same as before and no information is disclosed to the raiders. In addition, suppose that  $F$  also generates a signal (not revealed to the raiders) according to the initial disclosure policy. The period-two wages and severance payments of  $A$ ,  $(w_2'', s'')$ , are based on the realized  $x$  values.  $F$  sets  $w_2'' = s'' = \hat{w}_2'' = \hat{s}''$ , where  $\hat{s}''$  is given by the equation (25)

$$(25) \quad \bar{a}_H + \hat{s}''(x, y_1) = \max \{b(x) + \hat{s}(x, y_1), \hat{w}_2(x, y_1)\} \quad \forall x \in X.$$

Now, by arguments similar to the proof of Proposition 4 it can be shown that firm's payoff associated with this equilibrium is higher than the payoff associated with the initial equilibrium.

For the case  $\mathbb{E}(a) < \bar{a}_H - P_1 m$  the argument is again the same as in Proposition 4. Given any long-term complete contract with an arbitrary disclosure policy, replace it with the following one. Keep first-period wages same set the disclosure policy to be  $\delta^* = (\alpha_H = 1, \alpha_L = \alpha_L^*)$  (where  $\alpha_L^*$  is as defined in (22)). In addition, suppose  $F$  draws another signal  $x \in X$  (not revealed to the raiders) according to the initial disclosure policy. The period-two wages and severance payments of  $A$ ,  $(w_2''', s''')$ , are based on the realized  $x$  values.  $F$  sets  $w_2''' = s''' = \hat{w}_2''' = \hat{s}'''$  such that the agent's payoff is the same for every output-signal realization. Now by the same argument as before the profit is higher under this contract.

■

**Proof of Corollary 2:** Recall that  $\alpha_L^*$  solves  $\mathbb{E}(a | x_H) = \bar{a}_H - P_1 m$  when  $\alpha_H = 1$ . The result follows from the fact that  $\mathbb{E}(a | x_H)$  is decreasing in  $\alpha_L$ . ■

**Proof of Proposition 5:** The “if” part of the result is already prove in the text. To prove the “only if” part, first consider condition a) in (5’).

It is enough to show that if  $(P_1 - P_0)(\bar{a}_H - \bar{a}_L) \leq \psi$  then even if  $A$  faces a liquidity constraint, the profit to  $F$  under the optimal short-term performance contract with full disclosure is at least as large as the profit associated under an optimal short-term contract with an arbitrary disclosure policy. This proof is similar to the proof of Proposition 1.

**Step 1.** Consider an optimal short-term contract with an arbitrary disclosure policy  $\delta$  that is a feasible solution to  $\mathcal{P}$  when  $A$  faces a liquidity constraint. Let the associated period-one wage be  $w_1(y_1) \geq 0$ . Define  $X_H \subseteq X$  and  $X_L = X \setminus X_H$  as in Proposition 1. By virtue of optimality, given the bidding strategy of the raiders,  $\hat{w}_2(y_H, x) = \bar{a}_L + m = b(x) \quad \forall x \in X_L$ . The profit to  $F$  under this contract is

$$\Pi = P_1 (y_H - w_1 (y_H)) + (1 - P_1) (y_L - w_1 (y_L)) + P_1 \int_{X_L} (\bar{a}_H - (\bar{a}_L + m)) \delta (x | y_H) dx.$$

**Step 2.** I replace this contract by another short-term performance contract with full disclosure where the first-period wage,  $w_1^* (y_1)$ , is given by the following equations

$$(26) \quad w_1^* (y_H) + \bar{a}_H + m = w_1 (y_H) + \int_{X_H} b(x) \delta (x | y_H) dx + \int_{X_L} (\bar{a}_L + m) \delta (x | y_H) dx,$$

$$(27) \quad w_1^* (y_L) + \bar{a}_L + m = w_1 (y_L) + \int_{X_H} b(x) \delta (x | y_L) dx + \int_{X_L} (\bar{a}_L + m) \delta (x | y_L) dx.$$

By construction,  $A$  gets the same expected utility and faces the same incentives as in the initial contract.

**Step 3.** Equation (27) implies  $w_1^* (y_L) \geq w_1 (y_L) \geq 0$  as  $\bar{a}_L + m \leq \int_{X_H} b(x) \delta (x | y_L) dx + \int_{X_L} (\bar{a}_L + m) \delta (x | y_L) dx$ . I also claim that  $w_1^* (y_H) \geq 0$ . As the initial contract is a feasible one and in the new contract  $A$  faces the same incentives by construction, it must be the case that

$$\begin{aligned} & (P_1 - P_0) [w_1^* (y_H) + b(x_H) - (w_1^* (y_L) + b(x_L))] \\ &= (P_1 - P_0) [(w_1^* (y_H) - w_1^* (y_L)) + (\bar{a}_H - \bar{a}_L)] \\ &\geq \psi. \end{aligned}$$

As  $(P_1 - P_0) (\bar{a}_H - \bar{a}_L) \leq \psi$ , I conclude that  $w_1^* (y_H) - w_1^* (y_L) \geq 0$  or  $w_1^* (y_H) \geq w_1^* (y_L) \geq 0$ . Hence  $w_1^* (y_1)$  as defined above is feasible even when  $A$  faces a liquidity constraint.

**Step 4.** Profit to  $F$  under the new contract following  $y_1 = y_L$  is

$$\begin{aligned} \Pi_L^* &= (y_L - w_1^* (y_L)) \\ &= y_L - w_1 (y_L) - \int_{X_H} b(x) \delta (x | y_L) dx - \int_{X_L} (\bar{a}_L + m) \delta (x | y_L) dx + \bar{a}_L + m \end{aligned}$$

and following  $y_1 = y_H$  is

$$\begin{aligned} \Pi_H^* &= (y_H - w_1^* (y_H)) \\ &= y_H - w_1 (y_H) - \int_{X_H} b(x) \delta (x | y_H) dx - \int_{X_L} (\bar{a}_L + m) \delta (x | y_H) dx + \bar{a}_H + m \\ &> y_H - w_1 (y_H) - \int_{X_H} b(x) \delta (x | y_H) dx + \\ &\quad \int_{X_L} \{\bar{a}_H - (\bar{a}_L + m)\} \delta (x | y_H) dx - \int_{X_L} (\bar{a}_H + m) \delta (x | y_H) dx + \bar{a}_H + m. \end{aligned}$$

**Step 5.** The profit to  $F$  under the new contract is



$$\begin{aligned}
\Pi^* &= P_1 \Pi_H^* + (1 - P_1) \Pi_L^* \\
&\geq P_1 (y_H - w_1(y_H)) + (1 - P_1) (y_L - w_1(y_L)) + P_1 \left[ \bar{a}_H + m - \int_{X_H} b(x) \delta(x | y_H) dx \right. \\
&\quad \left. + \int_{X_L} \{\bar{a}_H - (\bar{a}_L + m)\} \delta(x | y_H) dx - \int_{X_L} (\bar{a}_H + m) \delta(x | y_H) dx \right] \\
&\quad + (1 - P_1) \left[ \bar{a}_L + m - \int_{X_H} b(x) \delta(x | y_L) dx - \int_{X_L} (\bar{a}_L + m) \delta(x | y_L) dx \right]
\end{aligned}$$

Using the fact that  $P_1 \bar{a}_H + (1 - P_1) \bar{a}_L = \mathbb{E}(a)$ , the above expression can be written as

$$\begin{aligned}
\Pi^* &\geq \Pi + \mathbb{E}(a) + m - P_1 \left[ \int_{X_H} b(x) \delta(x | y_H) dx + \int_{X_L} (\bar{a}_H + m) \delta(x | y_H) dx \right] \\
&\quad - (1 - P_1) \left[ \int_{X_H} b(x) \delta(x | y_L) dx + \int_{X_L} (\bar{a}_L + m) \delta(x | y_L) dx \right].
\end{aligned}$$

Hence, to prove  $\Pi^* \geq \Pi$  it is enough to show that

$$\begin{aligned}
\mathbb{E}(a) + m &\geq P_1 \left[ \int_{X_H} b(x) \delta(x | y_H) dx + \int_{X_L} (\bar{a}_H + m) \delta(x | y_H) dx \right] \\
&\quad + (1 - P_1) \left[ \int_{X_H} b(x) \delta(x | y_L) dx + \int_{X_L} (\bar{a}_L + m) \delta(x | y_L) dx \right].
\end{aligned}$$

But in Step 5 of the proof of Proposition 1, I have already shown that the above condition is true.

This observation completes the proof.

Consider condition *b*) now. I have already shown that condition *a*) is sufficient to induce full disclosure. Therefore I only need to consider the case

$$(5'') \quad (P_1 - P_0) (\bar{a}_H - \bar{a}_L) > \psi \quad \text{but} \quad \mathbb{E}(a) + m \leq \psi.$$

**Step 1.** Consider any feasible solution to the optimal contracting problem with liquidity constraint where disclosure is partial. Let the first-period wage be  $w_1(y_1) \geq 0$ . Again, define  $X_H \subseteq X$  and  $X_L = X \setminus X_H$  as before. By virtue of optimality, given the bidding strategy of the raiders,  $\hat{w}_2(y_H, x) = \bar{a}_L + m = b(x) \forall x \in X_L$ . The (*IC*) and (*IR*) constraints under such a solution are

$$(IC) \quad \Delta_{y_1} \left[ w_1(y_1) + \int_{X_H} b(x) \delta(x | y_1) dx + \int_{X_L} (\bar{a}_L + m) \delta(x | y_1) dx \right] \geq \frac{\psi}{(P_1 - P_0)}$$

and

$$(IR) \quad \mathbb{E}_{y_1} \left[ w_1(y_1) + \int_{X_H} b(x) \delta(x | y_1) dx + \int_{X_L} (\bar{a}_L + m) \delta(x | y_1) dx \right] \geq \psi.$$

Rewrite the (*IR*) constraint as

$$(IR') \quad \mathbb{E}_{y_1} w_1 \geq \psi - \mathbb{E}_{y_1} \left[ \int_{X_H} b(x) \delta(x | y_1) dx + \int_{X_L} (\bar{a}_L + m) \delta(x | y_1) dx \right].$$

As before, the profit to  $F$  under this contract is

$$\Pi = \mathbb{E}_{y_1} (y_1 - w_1(y_1)) + P_1 (\bar{a}_H - (\bar{a}_L + m)) \int_{X_L} \delta(x | y_H) dx.$$

**Step 2.** Now, consider a short-term performance contract with full disclosure. Under (5'') one can set  $w_1(y_H) = w_1(y_L) = w^*$  where  $w^* = \psi - (\mathbb{E}(a) + m)$ . The profit to  $F$  under this contract is

$$\Pi^* = \mathbb{E} y_1 - w^*.$$

It remains to show that

$$(28) \quad \Pi^* \geq \Pi \Leftrightarrow \mathbb{E}_{y_1} w_1 - w^* \geq P_1 (\bar{a}_H - (\bar{a}_L + m)) \int_{X_L} \delta(x | y_H) dx.$$

**Step 3.** From (IR') it follows that

$$\mathbb{E}_{y_1} w_1 - w^* \geq \psi - \mathbb{E}_{y_1} \left[ \int_{X_H} b(x) \delta(x | y_1) dx + \int_{X_L} (\bar{a}_L + m) \delta(x | y_1) dx \right] - w^*.$$

So, it is enough to show that

$$\begin{aligned} & \psi - \mathbb{E}_{y_1} \left[ \int_{X_H} b(x) \delta(x | y_1) dx + \int_{X_L} (\bar{a}_L + m) \delta(x | y_1) dx \right] - (\psi - (\mathbb{E}(a) + m)) \\ & \geq P_1 (\bar{a}_H - (\bar{a}_L + m)) \int_{X_L} \delta(x | y_H) dx, \end{aligned}$$

or,

$$(29) \quad \mathbb{E}(a) + m \geq \mathbb{E}_{y_1} \left[ \int_{X_H} b(x) \delta(x | y_1) dx + \int_{X_L} (\bar{a}_L + m) \delta(x | y_1) dx \right] + P_1 (\bar{a}_H - (\bar{a}_L + m)) \int_{X_L} \delta(x | y_H) dx.$$

**Step 4.** The right hand side of (29) can be rewritten as

$$\begin{aligned} & P_1 \left[ \int_{X_H} b(x) \delta(x | y_H) dx + \int_{X_L} (\bar{a}_L + m) \delta(x | y_H) dx \right] + \\ & (1 - P_1) \left[ \int_{X_H} b(x) \delta(x | y_L) dx + \int_{X_L} (\bar{a}_L + m) \delta(x | y_L) dx \right] + \\ & P_1 \{ (\bar{a}_H + m) - (\bar{a}_L + m) \} \int_{X_L} \delta(x | y_H) dx - m P_1 \int_{X_L} \delta(x | y_H) dx. \end{aligned}$$

Rearranging the terms, one gets

$$P_1 \left[ \int_{X_H} b(x) \delta(x | y_H) dx + \int_{X_L} (\bar{a}_H + m) \delta(x | y_H) dx \right] + (1 - P_1) \left[ \int_{X_H} b(x) \delta(x | y_L) dx + \int_{X_L} (\bar{a}_L + m) \delta(x | y_L) dx \right] - mP_1 \int_{X_L} \delta(x | y_H) dx.$$

or,

$$\mathbb{E}(a) + m - mP_1 \int_{X_L} \delta(x | y_H) dx$$

(by using the expression for  $\mathbb{E}(a) + m$  as derived in Step 5 of the proof of Proposition 1). Hence, the condition (29) is satisfied. ■

**Proof of Proposition 6.** This proof is again similar to the proof of Proposition 5.

**Step 1.** Consider an optimal short-term performance contract with an arbitrary partial disclosure policy  $\delta$ . Let the associated first-period wage be  $w_1(y_1)$  and define  $X_H \subseteq X$  and  $X_L = X \setminus X_H$  as before. Again By virtue of optimality, given the bidding strategy of the raiders,  $\hat{w}_2(y_H, x) = \bar{a}_L + m = b(x) \forall x \in X_L$ . The profit to  $F$  under this contract is

$$\Pi = P_1 (y_H - w_1(y_H)) + (1 - P_1) (y_L - w_1(y_L)) + P_1 \int_{X_L} (\bar{a}_H - (\bar{a}_L + m)) \delta(x | y_H) dx.$$

Upon realizing  $y_1 = y_i$ , the payoff of the agent is

$$\int_X u(w_1(y_i) + b(x)) \delta(x | y_i) dx, i = L, H.$$

**Step 2.** Consider another short-term contract with full transparency and wage  $w_1^*(y_i)$  where

$$u(w_1^*(y_i) + (\bar{a}_i + m)) = \int_X u(w_1(y_i) + b(x)) \delta(x | y_i) dx, i = L, H.$$

Now,

$$u(w_1^*(y_i) + (\bar{a}_i + m)) \leq u\left(w_1(y_i) + \int_X b(x) \delta(x | y_i) dx\right), i = L, H.$$

(by Jensen's inequality), or,

$$(30) \quad w_1^*(y_i) + (\bar{a}_i + m) \leq w_1(y_i) + \int_X b(x) \delta(x | y_i) dx, i = L, H.$$

**Step 3.** Using (30), it follows that the profit to  $F$  following  $y_1 = y_L$  is

$$\begin{aligned}\Pi_L^* &= (y_L - w_1^*(y_L)) \\ &\geq y_L - w_1(y_L) - \int_{X_H} b(x) \delta(x | y_L) dx - \int_{X_L} (\bar{a}_L + m) \delta(x | y_L) dx + \bar{a}_L + m\end{aligned}$$

and following  $y_1 = y_H$  is

$$\begin{aligned}\Pi_H^* &= (y_H - w_1^*(y_H)) \\ &\geq y_H - w_1(y_H) - \int_{X_H} b(x) \delta(x | y_H) dx + \int_{X_L} (\bar{a}_L + m) \delta(x | y_H) dx + \bar{a}_H + m \\ &> y_H - w_1(y_H) - \int_{X_H} b(x) \delta(x | y_H) dx + \\ &\quad \int_{X_L} \{\bar{a}_H - (\bar{a}_L + m)\} \delta(x | y_H) dx - \int_{X_L} (\bar{a}_H + m) \delta(x | y_H) dx + \bar{a}_H + m.\end{aligned}$$

So,  $F$ 's profit under this contract is

$$\begin{aligned}\Pi^* &= P_1 \Pi_H^* + (1 - P_1) \Pi_L^* > P_1 (y_H - w_1(y_H)) + (1 - P_1) (y_L - w_1(y_L)) \\ &\quad + P_1 \left[ \bar{a}_H + m - \int_{X_H} b(x) \delta(x | y_H) dx - \int_{X_L} (\bar{a}_L + m) \delta(x | y_H) dx \right] \\ &\quad + (1 - P_1) \left[ \bar{a}_L + m - \int_{X_H} b(x) \delta(x | y_L) dx - \int_{X_L} (\bar{a}_L + m) \delta(x | y_L) dx \right].\end{aligned}$$

Step 5 of Proposition 5, proves that  $\Pi^* > \Pi$ . ■

#### APPENDIX B. GENERALIZATION OF BENCHMARK RESULTS:

**Proof of Proposition 1 — continuum of types:** Recall that the bidding function of the raider is given as

$$b(x) = \begin{cases} \mathbb{E}(a | x) + m & \text{if } \mathbb{E}(a | x) + m > \mathbb{E}(a | \bar{y}) \\ b^*(x) & \text{otherwise} \end{cases},$$

where  $b^*(x)$  solves the following equation

$$b^*(x) = \mathbb{E}_{y_1} [\mathbb{E}_a [a | x, y_1, \mathbb{E}(a | y_1) < b^*(x)] | x] + m.$$

As  $\partial \mathbb{E}(a | y_1) / \partial y_1 > 0$ ,  $\exists$  a value of  $y_1$  depending on  $b^*(x)$ ,  $y_1(b^*(x)) (= y_1^*(x))$ , say) such that  $[\mathbb{E}(a | y_1) < b^*(x)] \Leftrightarrow [y_1 < y_1^*(x)]$ . Therefore,

$$\begin{aligned}b^*(x) &= \mathbb{E}_{y_1} [\mathbb{E}_a [a | x, y_1, \mathbb{E}(a | y_1) < b^*(x)] | x] + m \\ &= \mathbb{E}_{y_1} [\mathbb{E}_a [a | x, y_1, y_1 < y_1^*(x)] | x] + m \\ &= \mathbb{E}_{y_1} [\mathbb{E}_a (a | y_1) | x, y_1 < y_1^*(x)] + m \\ &= \frac{1}{\Pr(y_1 \leq y_1^*(x))} \int_{\underline{y}}^{y_1^*(x)} \mathbb{E}_a (a | y_1) f(y_1 | x) dx + m,\end{aligned}$$

where  $f(y_1 | x)$  is the distribution function of  $y_1$  conditional on  $x$  which is induced by the associated disclosure policy  $\delta(x | y_1)$ . The rest of the proof is shown in the following steps.

**Step 1.** Consider a long-term complete contract with an arbitrary partial disclosure policy that is feasible in the optimal contracting problem.

Define  $X_H = \{x \in X(\delta) \mid b(x) \geq \mathbb{E}(a \mid \bar{y})\}$  and  $X_L = X \setminus X_H$ . Furthermore, let  $X_L(y_1) = \{x \in X_L \mid b(x) < \mathbb{E}(a \mid y_1)\}$ . The bidding function for the raiders implies that there is no turnover iff  $\forall y_1, \forall x \in X_L(y_1)$ . Therefore, the profit to  $F$  under the above contract is

$$\Pi = \int_Y \left[ (y - \mathbb{E}(w_1 \mid y_1)) + \left[ \int_{X_L(y_1)} (\mathbb{E}(a \mid y_1) - b^*(x)) - \int_{X \setminus X_L(y_1)} \hat{s}(x, y_1) \right] \delta(x \mid y_1) \right] f(y) dy_1.$$

Here, I use the fact that  $\forall y_1, \forall x \in X_L(y_1), \hat{w}_2(x, y_1) = b^*(x)$ .

**Step 2.** Define a fully transparent disclosure policy as

$$\delta(x \mid y_1) = \begin{cases} 1 & \text{if } x = x(y_1) \\ 0 & \text{otherwise} \end{cases},$$

where  $x : Y \rightarrow X$  is a one-to-one function.

Consider another long-term complete contract with a fully transparent disclosure policy. In addition, suppose that  $F$  also generates another signal  $x \in X$  according to the disclosure policy  $\delta$ . The period-two wages and severance payments of  $A$ ,  $(w_2^*, s^*)$ , are based on the realized  $x$  values. Let  $w_1$  be unchanged from the initial contract and set  $w_2^* = s^* = \hat{w}_2^* = \hat{s}^*$  where  $\hat{s}^*$  is given by equation (11), i.e.,

$$b(x(y_1)) + \hat{s}^*(x, y_1) = \max \{b(x) + \hat{s}(x, y_1), \hat{w}_2(x, y_1)\} \quad \forall x \in X \text{ and } y_1 \in Y,$$

where  $b(x(y_1)) = \mathbb{E}(a \mid y_1) + m$  is the bid of the raiders when  $y_1$  is directly revealed under full transparency. By construction, facing this contract  $A$  will choose the same effort level and receive the same expected utility as in the initial contract.

**Step 3.** Under the new contract, following  $y_1 = y_i$ ,  $F$ 's profit will be

$$\Pi_i^* = \int_Y \left[ y_i - \mathbb{E}(w_1 \mid y_i) - \int_X \hat{s}^*(x, y_i) \delta(x \mid y_i) dx \right] f(y_1) dy_1, \quad i = L, H.$$

I claim that  $F$ 's profit under the new contract,  $\Pi^* \geq \Pi$ .

**Step 4.** Using (11), one gets

$$\begin{aligned}
\Pi^* &= \int_Y [(y_1 - \mathbb{E}(w_1 | y_1)) + [\int_{X_L(y_1)} ((\mathbb{E}(a | y_1) + m) - b^*(x)) \\
&\quad + \int_{X \setminus X_L(y_1)} ((\mathbb{E}(a | y_1) + m) - b(x) - \hat{s}(x, y_1))] \delta(x | y_1) dx] f(y_1) dy_1 \\
&\geq \int_Y [(y_1 - \mathbb{E}(w_1 | y_1)) + [\int_{X_L(y_1)} (\mathbb{E}(a | y_1) - b^*(x)) \\
&\quad + \int_{X_L(y_1)} (\mathbb{E}(a | y_1) + m) - \int_{X_L(y_1)} (\mathbb{E}(a | y_1) + m) \\
&\quad + \int_{X \setminus X_L(y_1)} ((\mathbb{E}(a | y_1) + m) - b(x) - \hat{s}(x, y_1))] \delta(x | y_1) dx] f(y_1) dy_1.
\end{aligned}$$

Hence,

$$\Pi^* \geq \Pi + \mathbb{E}(a) + m - \int_Y \left[ \int_{X_L(y_1)} (\mathbb{E}(a | y_1) + m) + \int_{X \setminus X_L(y_1)} b(x) \right] \delta(x | y_1) dx \Big] f(y_1) dy_1.$$

**Step 5.** To prove  $\Pi^* \geq \Pi$ , it is enough to show that

$$(31) \quad \mathbb{E}(a) + m \geq \int_Y \left[ \int_{X_L(y_1)} (\mathbb{E}(a | y_1) + m) + \int_{X \setminus X_L(y_1)} b(x) \right] \delta(x | y_1) dx \Big] f(y_1) dy_1.$$

Now, the right hand side of (31) can be written as:

$$\begin{aligned}
&\int_Y \int_{X_H} b(x) \delta(x | y_1) dx f(y_1) dy_1 + \\
&\int_Y \left[ \int_{X_L(y_1)} (\mathbb{E}(a | y_1) + m) + \int_{X_L \setminus X_L(y_1)} b(x) \right] \delta(x | y_1) dx f(y_1) dy_1.
\end{aligned}$$

**Step 6.** Observe that,

$$\begin{aligned}
&\int_Y \int_{X_H} b(x) \delta(x | y_1) dx f(y_1) dy_1 = \int_{X_H} b(x) \int_Y \delta(x | y_1) f(y_1) dy_1 dx \\
&= \int_{X_H} (\mathbb{E}(a | x) + m) \delta(x) dx
\end{aligned}$$

Moreover,

$$\begin{aligned}
&\int_Y \left[ \int_{X_L(y_1)} (\mathbb{E}(a | y_1) + m) + \int_{X_L \setminus X_L(y_1)} b(x) \right] \delta(x | y_1) dx f(y_1) dy_1 \\
&= \int_{X_L} \left[ \int_{Y(x)} (\mathbb{E}(a | x, y_1) + m) + \int_{Y \setminus Y(x)} b(x) \right] f(y_1 | x) dy_1 f(x) dx,
\end{aligned}$$

where  $Y(x) = \{y_1 \in Y \mid \mathbb{E}(a | y_1) > b^*(x)\} = \{y_1 \mid y_1 > y_1^*(x)\}$ . Now, using the fact that  $\mathbb{E}(a | x, y_1) = \mathbb{E}(a | y_1)$ , I get

$$\begin{aligned}
& \int_{X_L} \left[ \int_{Y(x)} (\mathbb{E}(a | x, y_1) + m) + \int_{Y \setminus Y(x)} b(x) \right] f(y_1 | x) dy_1 f(x) dx \\
&= \int_{X_L} \left[ \int_{y_1(x^*)}^{\bar{y}} (\mathbb{E}(a | x, y_1) + m) + \int_{\underline{y}}^{y_1(x^*)} b(x) \right] f(y_1 | x) dy_1 f(x) dx \\
&= \int_{X_L} \int_{y_1(x^*)}^{\bar{y}} (\mathbb{E}(a | x, y_1) + m) f(y_1 | x) dy_1 f(x) dx \\
&+ \int_{X_L} \int_{\underline{y}}^{y_1(x^*)} \left[ \frac{1}{\Pr(y_1 \leq y_1^*(x))} \int_{\underline{y}}^{y_1^*(x)} \mathbb{E}_a(a | y_1) f(y_1 | x) dx \right] f(y_1 | x) dy_1 f(x) dx \\
&= \int_{X_L} \int_{y_1(x^*)}^{\bar{y}} (\mathbb{E}(a | x, y_1) + m) f(y_1 | x) dy_1 f(x) dx \\
&\quad + \int_{X_L} \int_{\underline{y}}^{y_1^*(x)} \mathbb{E}_a(a | x, y_1) f(y_1 | x) dx f(x) dx \\
&= \int_{X_L} (\mathbb{E}(a | x) + m) \delta(x) dx
\end{aligned}$$

**Step 7.** From Step 6, one can write

$$\begin{aligned}
& \int_Y \left[ \int_{X_L(y_1)} (\mathbb{E}(a | y_1) + m) + \int_{X \setminus X_L(y_1)} b(x) \right] \delta(x | y_1) dx f(y_1) dy_1 \\
&= \int_{X_H} (\mathbb{E}(a | x) + m) \delta(x) dx + \int_{X_L} (\mathbb{E}(a | x) + m) \delta(x) dx \\
&= \mathbb{E}(a) + m,
\end{aligned}$$

i.e., the condition (31) holds with an equality. ■

**Proof of Proposition 1 — ability dependent matching factor:** This proof is similar to the proof of Proposition 1 and is given in the following steps.

**Step 1.** Fix an arbitrary disclosure policy  $\delta$ . Consider the optimal long-term complete contract in the restricted program where the disclosure policy is fixed at  $\delta$ . Define  $X_H$  and  $X_L$  as in the proof of Proposition 1. The bidding function for the raiders implies that there is no turnover iff  $x \in X_L$ . As the contract is an optimal one in the restricted program, whenever the agent is retained, his wage is equal to the raiders' bid  $\mathbb{E}(a + m(a) | y_L)$ . Therefore, the profit to  $F$  under the above contract is

$$\begin{aligned}
\Pi &= P_1 (y_H - \mathbb{E}(w_1 | y_H)) + (1 - P_1) (y_L - \mathbb{E}(w_1 | y_L)) + \\
&\quad P_1 \left( - \int_{X_H} \hat{s}(x, y_H) + \int_{X_L} (\bar{a}_H - \mathbb{E}(a + m(a) | y_L)) \right) \delta(x | y_H) dx \\
&\quad + (1 - P_1) \left( - \int_{X_H} \hat{s}(x, y_L) + \int_{X_L} (\bar{a}_L - \mathbb{E}(a + m(a) | y_L)) \right) \delta(x | y_L) dx.
\end{aligned}$$

**Step 2.** Consider another candidate solution to the unrestricted problem as follows: Let the associated disclosure policy be fully transparent. In addition, suppose that  $F$  also generates another signal  $x \in X$  according to the disclosure policy  $\delta$ . The period-two wages and severance payments of  $A$ ,  $(w_2^*, s^*)$ , are based on the realized  $x$  values. Let  $w_1$  be unchanged from the initial contract. The second-period wages and severance payments are set as follows:

*i)*  $\forall x \in X$  and  $y_1 = y_H$ ,  $w_2^* = s^* = \hat{w}_2^* = \hat{s}^*$  where  $\hat{s}^*$  is given by the equation

$$\mathbb{E}(a + m(a) | y_H) + \hat{s}^*(x, y_H) = \max \{ b(x) + \hat{s}(x, y_H), \mathbb{E}(a + m(a) | y_L) \}.$$

ii)  $\forall x \in X$  and  $y_1 = y_L$ ,  $s^* = \hat{s}^* = 0$  but  $w_2^* = \hat{w}_2^*$  where  $\hat{w}_2^*$  is given by the equation

$$\hat{w}_2^*(x, y_L) = \max \{b(x) + \hat{s}(x, y_L), \mathbb{E}(a + m(a) | y_L)\}.$$

By construction, facing this contract  $A$  will choose the same effort level and receive the same expected utility as in the initial contract. Let  $\Pi^*$  be the profit of  $F$  under this contract. It remains to show that  $\Pi^* \geq \Pi$ .

**Step 3.** Using *i*) and *ii*), one can write

$$\begin{aligned} \Pi^* &= \Pi + P_1 \left[ \mathbb{E}(a + m(a) | y_H) - \int_{X_H} b(x) \delta(x | y_H) dx - \int_{X_L} \mathbb{E}(a + m(a) | y_H) \delta(x | y_H) dx \right] \\ &\quad + (1 - P_1) \left[ \int_{X_H} (\bar{a}_L - b(x)) \delta(x | y_L) dx \right]. \end{aligned}$$

Hence, to prove  $\Pi^* \geq \Pi$ , it is enough to show that

$$(32) \quad \begin{aligned} &P_1 \left[ \mathbb{E}(a + m(a) | y_H) - \int_{X_H} b(x) \delta(x | y_H) dx - \int_{X_L} \mathbb{E}(a + m(a) | y_H) \delta(x | y_H) dx \right] \\ &+ (1 - P_1) \left[ \int_{X_H} (\bar{a}_L - b(x)) \delta(x | y_L) dx \right] \geq 0. \end{aligned}$$

**Step 4.** Observe that

$$\begin{aligned} \int_{X_H} (\bar{a}_L - b(x)) \delta(x | y_L) dx &\geq \mathbb{E}(a + m(a) | y_L) - \int_{X_H} [b(x) \delta(x | y_L) dx \\ &\quad + \int_{X_L} \mathbb{E}(a + m(a) | y_L) \delta(x | y_L) dx], \end{aligned}$$

as  $\mathbb{E}(m(a) | y_L) < 0$ . Hence, (32) is true if

$$\begin{aligned} &P_1 \left[ \mathbb{E}(a + m(a) | y_H) - \int_{X_H} b(x) \delta(x | y_H) dx - \int_{X_L} \mathbb{E}(a + m(a) | y_H) \delta(x | y_H) dx \right] + \\ &(1 - P_1) \left[ \mathbb{E}(a + m(a) | y_L) - \int_{X_H} [b(x) \delta(x | y_L) dx - \int_{X_L} \mathbb{E}(a + m(a) | y_L) \delta(x | y_L) dx] \right] \\ &\geq 0, \end{aligned}$$

or,

$$\begin{aligned} \mathbb{E}(a + m(a)) &\geq \int_{X_H} b(x) [P_1 \delta(x | y_H) + (1 - P_1) \delta(x | y_L)] dx + \\ &\int_{X_L} \mathbb{E}(a + m(a) | y_H) \delta(x | y_H) dx + \int_{X_L} \mathbb{E}(a + m(a) | y_L) \delta(x | y_L) dx. \end{aligned}$$

But by Step 5 of Proposition 1, the above condition holds with equality. ■