THE ROLE OF PROMOTION IN INDUCING SPECIFIC HUMAN CAPITAL ACQUISITION*

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Workers routinely carry out activities that increase their productivity with their current employer for which they are not directly compensated. For example, a worker may be asked to develop relationships with clients or shop floor staff, or he may develop a better understanding of how his firm operates. Firm-specific human capital of this type is difficult to quantify so that it is likely to be difficult to directly compensate the worker for its acquisition. This paper is concerned with designing compensation schemes for employees to induce them to collect nonverifiable firm-specific human capital.

If firms develop reputations for fairly compensating workers for skill collection, the vagueness of these skills may not provide a significant incentive problem. I consider the case where firms do not have the opportunity to develop reputations. As a result, the acquisition of human capital is subject to a dual moral hazard problem, first noted in Kahn and Huberman [1988]. First, a worker only collects skills if there is a promise of a higher wage if he does so. Second, the employer has an incentive to claim that the worker has not collected these skills even when he in fact has, in order to save on wage costs.

So, on the one hand, it is difficult to repay the worker after skills are collected as the firm has an incentive to renege. However, the worker cannot be repaid before collecting skills as he has no subsequent incentive to collect them. Following the institutional literature, I assume that the firm can commit to a labor contract which attaches wages to different tasks. The principal purpose of the paper is to show that the firm can use this ability to commit to a wage scale for different tasks to induce a worker to collect firm-specific human capital in the presence of this dual moral hazard problem, where the worker is rewarded for skill acquisition by promotion to another job.

Assume that a worker can be assigned to one of two jobs, D and

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E. Let promotion to job D carry a wage premium of one dollar. Whether the worker trains then depends on two issues: (i) is a dollar large enough to induce the worker to train, conditional on the worker having a higher chance of promotion to job D if he trains; and (ii) does the worker have a higher chance of promotion if he trains? If the worker can carry out only one task, the firm never pays a premium to a trained worker absent reputational concerns and so the worker does not train. With two jobs the worker's productivity may be higher in job D after training. Then if promoting the worker to job D increases the worker's productivity by more than a dollar, the firm promotes him after training and hence compensates him for collecting skills. A key consideration here is that the worker's productivity must be higher if he is promoted. Hence the firm cannot overcome its incentive to appropriate simply by creating job titles. Separate tasks are required.

In a recent paper Baker, Jensen, and Murphy [1988, p. 593] note the "overwhelming use of promotion based [compensation] schemes" rather than directly compensating employees with pay for performance.¹ Baker et al. find this confusing as they believe that sorting workers to tasks should be separated from compensating workers for performance. This paper may help us to understand why this is the case. If firms cannot be trusted to compensate employees for skill collection, then perhaps the only way to induce them to train is by promotion to a different task. Hence, incentive and sorting issues are linked.

I begin in Section I by considering a simple example to illustrate how pay scales and promotion can give rise to efficient training by workers in the presence of two-sided moral hazard. I then consider a more general model to describe the costs and benefits of this type of labor contract. I conclude with a brief discussion of other means of inducing firm-specific skill collection, paying particular attention to the use of tournaments [Carmichael, 1983] and related work on up-or-out contracts by Kahn and Huberman [1988]. Here I make empirical predictions about the kinds of professions where promotion will be used as an alternative

¹. For example, Medoff and Abraham [1980] find survey evidence suggesting that between-job earnings differences are more important than within-job earnings differences. Lazear [1991] finds similar evidence from personnel files that most significant wage increases are accompanied by changes in job title. More systematic evidence is given in Groshen [1991]. She finds that for workers in industries not explicitly covered by incentive pay, within-job variance of wages accounts for only about 3–7 percent of the total variance of wages in her sample.
to up-or-out contracts, which seem consistent with empirical evidence.

I. An Example

A risk-neutral worker with reservation utility \( r \) is employed in a risk-neutral firm for a single period. His reservation utility must be earned in expected terms during the period. The worker can be assigned either to an easy job, job E, or a difficult job, job D. Before being assigned to a job, the worker can collect specific skills. Let \( s \) denote skills, where \( s = 1 \) implies that skills have been collected and \( s = 0 \) implies that they have not. The worker's utility is \( U = w - sc \), where \( w \) is the wage earned. Output or skills cannot be verified to a court or enforcing agency.

Given an efficient but nonverifiable investment opportunity, how can the firm induce the worker to incur the cost of the investment? To clarify the issues, initially consider a one-job model. In a one-job model, the firm will not pay the worker's cost of collecting human capital, absent reputational concerns. (It could promise to reward the worker with a higher wage, but after training, the firm has no incentive to do so in this one-period setting.) Also, having the firm pay the worker in advance will not induce skill collection, as the worker will not invest.

Now assume that there are two distinct tasks that the worker can carry out, a difficult task and an easy task. Furthermore, let us assume that the firm can commit to wages as a function of the task carried out. Let \( y_i(s) \) be the output in job \( i, i = D,E \), with training \( s, s = 0,1 \). Now assume that

\[
(1) \quad y_D(0) < y_E(0) < y_E(1) < y_D(1).
\]

This implies that (i) training increases productivity in both jobs, and (ii) a trained worker is efficiently assigned to job D while an untrained worker is efficiently assigned to job E. Thus, the returns to training are higher in job D than in job E. Assume that \( y_D(1) - y_E(0) > c \), so that training is efficient. Let \( w_i \) be the wage for job \( i, i = D,E \). The firm promotes the trained worker if

\[
(2) \quad y_D(1) - w_D \geq y_E(1) - w_E.
\]

Thus, allowing two jobs makes it potentially credible for the firm to repay the worker for collecting human capital. If this inequality holds, the worker trains if \( w_D - w_E \geq c \). Thus, to induce training,
the firm wishes to find wages \((w_D, w_E)\) such that
\[
y_D(1) - y_E(1) \geq w_D - w_E \geq c.
\]
By the assumption that training is efficient, \(y_D(1) - c > y_E(0)\), but this does not imply that \(y_D(1) - y_E(1) > c\). Hence the nonverifiability of investment prevents investment from occurring if \(y_D(1) - y_E(1) < c\). In other words, only if the firm's incentive to appropriate the returns to training is small, i.e., if \(y_E(1) - y_E(0)\) is small, can the efficient outcome be obtained.

This example illustrates that if (3) holds, the firm can use promotion to task D as an inducement to train as the extra productivity in job D overcomes the firm's incentive to appropriate. Since the firm can attach wages to the different tasks, the firm can use this as a form of commitment to induce skill collection. In the next section, this insight is generalized to allow more careful consideration of the existence of a contract that induces the worker to train and its efficiency properties.

II. A Model

A single worker with reservation utility \(r\) is employed in a firm for a single period. He can collect firm-specific skills, where \(s = 1\) denotes that skills are collected and \(s = 0\) implies that they are not. After collecting skills, the worker can be assigned to one of two jobs, an easy job, E or a difficult job D. He cannot be fired, nor can he quit after the contract is signed.\(^2\) Output in each job depends on \(s\) and the worker's unobservable characteristics, which I denote by \(\eta\). \(\eta\) denotes the worker's ability or match to the firm.\(^3\) I assume that \(\eta\) is uniformly distributed over \([0,1]\) and is unknown to both the employer and the worker before training. Output in job E and output in job D are given by \(y_E(\eta,s)\) and \(y_D(\eta,s)\), respectively, where output is nondecreasing in each arguments for each job. The technology is commonly known.

I make two assumptions on the technology. First, the difficult job is more suited to those with high ability while the low ability

\(^2\) See Section III for a discussion of up-or-out contracts, where the worker can be laid off.

\(^3\) Waldman [1984] considers the case where firms infer information on a worker's ability from promotion. Hence wages rise discretely on promotion. This leads to underpromotion as firms must make discretely higher profits upon promotion of the worker to compensate for the higher wage. Introducing this effect into this model does not qualitatively change its results.
have a comparative advantage in job E. Second, training is more productive in job D than job E. This is formalized in Assumption 1.

**Assumption 1.** (i) \( y_{D1}(\eta,s) \geq y_{E1}(\eta,s) \geq 0 \), for all \( s \); (ii) \( y_D(\eta,1) - y_D(\eta,0) > y_E(\eta,1) - y_E(\eta,0) \) for all \( \eta \in [0,1] \), where \( y_{i1} \) refers to the derivative of \( y_i \) with respect to ability.

The firm is assumed to observe the worker’s productivity in each job after training but before assigning him to a position. The firm is risk neutral and maximizes expected profits, output minus wages, while the worker maximizes \( U = w - cs \), where \( w \) is the wage paid. I assume that wages cannot be conditioned on the worker’s output or on his training decision. However, the firm can specify a wage for each job, with the contract denoted by \( \sigma = [w_E, w_D] \).

As in the example above, there are incentive compatibility constraints for both the firm and the worker. First, the worker only trains if the expected return from doing so is at least \( c \). This is the worker’s incentive compatibility constraint, [WIC]. Second, the firm only assigns the worker to a better paid job if the profits from doing so exceed the profits from assigning the worker to a poorer paid job. This is the firm’s incentive compatibility constraint, [FIC]. Finally, the worker's individual rationality constraint, [WIR], is that he must earn utility of \( r \) in expected terms. The firm’s objective is to maximize profits subject to these constraints.

**Results**

By Assumption 1(ii), training increases the worker’s productivity in job D more than in job E. As a result, the worker can only be induced to collect firm-specific human capital by the possibility of being assigned to job D. I refer to a job D appointment as a promotion. By Assumption 1(i), there is a single critical level of ability above which the worker is promoted for each level of training. Let \( \eta^* \) be the critical level of ability above which the firm promotes the worker if he trains, and let \( \hat{\eta} \) be the critical level for promotion if he does not train. Then the worker only collects firm-specific skills if

[WIC] \[ \text{[prob} (\eta \geq \eta^*) - \text{[prob} (\eta \geq \hat{\eta})](w_D - w_E) \geq c. \]

But the firm promotes the worker only if the profits from doing exceed the profits from assigning the worker to job E. Hence \( \eta^* \) is defined by

[FIC*] \[ y_D(\eta^*,1) - y_E(\eta^*,1) = w_D - w_E, \]
assuming that an interior solution exists. \( \hat{\eta} \) is defined by

\[
[FIC] \quad y_D(\hat{\eta},0) - y_E(\hat{\eta},0) = w_D - w_E,
\]

assuming that an interior solution exists. By Assumption 1(ii), \( \eta^* \leq \hat{\eta} \); hence it is never more difficult to be promoted if the worker trains than if he does not for any \( \sigma \). Finally if the worker trains, the contract must be such that

\[
[WIR] \quad (1 - \eta^*)w_D + \eta^*w_E \geq r + c.
\]

The firm maximizes expected profits subject to [WIC], [FIC], [FIC*], and [WIR]. A contract that induces the worker to train exists only if [WIC], [WIR], [FIC], and [FIC*] hold. Among the set of contracts that satisfy these constraints, the firm chooses the contract that maximizes expected profits. This occurs at the lowest \( \eta^* \in [0,1] \) satisfying these constraints. Because the firm wishes to choose the lowest \( \eta^* \), this implies that [WIC] binds in equilibrium as \( \partial \eta^*/\partial(w_D - w_E) > 0 \), from [FIC*].

Existence of Equilibrium

It is not necessarily the case that a contract exists where the worker trains. To see this, note that if \( w_D - w_E = 0 \), there is no benefit to being promoted and hence to acquiring skills. Increasing \( w_D - w_E \) makes promotion more desirable (from [WIC]) but also increasingly unlikely, as the firm is reluctant to promote the worker (from [FIC]).

This problem is illustrated in Figure I. The worker’s ability must exceed \( \eta^*(\hat{\eta}) \) for the worker to be promoted if he has (not) trained. Hence \( 1 - \eta^*(1 - \hat{\eta}) \) in Figure I refers to the probability of promotion when the worker trains (does not train). By Assumption 1(ii), training is more valuable in job D than job E, so that the probability of promotion is higher when the worker trains. However, the probability of promotion falls as the wage raise on

4. Efficiency suggests that all above ability \( \alpha \) should be promoted, where \( y_E(\alpha,1) = y_D(\alpha,1) \). Since \( w_D > w_E \), all \( \eta^* > 0 \) which satisfy [FIC] exceed \( \alpha \), and so there is inefficient allocation of workers to jobs. Hence the firm should choose the lowest \( \eta^* \) which satisfy the constraints as this minimizes inefficient allocation of workers to jobs.

5. For example, let \( y_E(\eta,s) = (1 + s)/10, y_D(\eta,s) = \eta s \) and \( c = 0.4 \). Then from [WIC], \( (1 - \eta^*)|w_D - w_E| \geq 0.4 \). From [FIC], \( \eta^* - 0.2 = w_D - w_E \). [WIC] binds in equilibrium. Hence, combining these gives the quadratic equation \( (\eta^* - 0.2)(1 - \eta^*) = 0.4 \), which has no real roots.

6. The assumptions imposed on the technology do not place constraints on how the difference between these two lines changes with \( w_D - w_E \). The relationship in Figure I is linear only for expositional simplicity.
promotion increases. Hence $1 - \eta^*$ and $1 - \hat{\eta}$ are decreasing in $w_D - w_E$, as illustrated in the diagram. So, for example, the firm never promotes a trained (untrained) worker if the wage spread between job D and job E exceeds $\alpha(\beta)$.

Now consider the worker’s incentive to train. The incentive to train comes from the increased probability of promotion if he trains, which is represented in the diagram by the vertical distance between the two downward sloping lines. For example, for a wage premium of $\epsilon$, the distance $|\gamma \delta|$ is the increased probability of promotion. The worker’s incentive compatibility constraint binds in equilibrium, so that a wage premium $\epsilon$ can represent an equilibrium for $\eta^* > 0$ if $\epsilon = c / (\hat{\eta} - \eta^*) = c / |\gamma \delta|$. Thus, the wage premium $w_D - w_E = c / (\hat{\eta} - \eta^*)$ must be consistent with the increased probability of promotion given by $|\gamma \delta| = \hat{\eta} - \eta^*$. If $\eta^* > 0$, then existence of a contract where the worker trains requires that for some wage premium, $w_D - w_E = c / (\hat{\eta} - \eta^*)$, where $\hat{\eta} - \eta^*$ is the difference between the two downward sloping lines.$^7$

This figure provides a characterization of when firms cannot induce workers to collect human capital. In particular, consider the

7. For $\eta^* = 0$, existence requires that $w_D - w_E \geq c / \hat{\eta}$. 
case where \( \hat{\eta} - \eta^* \) is small; i.e., where the returns to training are similar in both jobs. Then the required \( w_D - w_E \) is large since the likelihood of promotion does not change much so that the worker must be offered a large wage premium as inducement to train. If the required wage premium exceeds \( \alpha \) in Figure I, then an equilibrium never exists where the worker trains. Then let \( \phi \) be defined by \( \alpha = c/\phi \). Then if \( \hat{\eta} - \eta^* < \phi \), for all wage spreads, no contract exists where the worker trains. In other words, there exists a critical wage premium \( \phi \), such that if training does not increase the probability of promotion by at least \( \phi \), the worker cannot be induced to train. Proposition 1 then illustrates the importance of separate tasks for this solution to the collection of specific skills.

**Proposition 1.** If training increases productivity in both jobs by a similar amount, no contract exists where the worker trains.

Thus, the firm cannot simply generate job titles, rather than separate tasks, to induce skill collection.

**Efficiency Properties**

The expected profits from a contract where the worker trains are

\[
\int_0^{\eta^*} y_E(\eta,1) \, d\eta + \int_{\eta^*}^1 y_D(\eta,1) \, d\eta - r - c = \Pi^*.
\]

If the firm does not induce the worker to collect human capital, it pays all workers \( r \) and assigns the worker to job D if \( \eta \geq \hat{\eta} \), where \( y_E(\hat{\eta},0) = y_D(\hat{\eta},0) \). The profits from not inducing training are

\[
\int_0^{\hat{\eta}} y_E(\eta,0) \, d\eta + \int_{\hat{\eta}}^1 y_D(\eta,0) \, d\eta - r = \bar{\Pi}.
\]

If a contract exists where the worker is induced to train, the profits from inducing the worker to train are higher if

\[
\int_0^{\eta^*} y_E(\eta,1) \, d\eta + \int_{\eta^*}^1 y_D(\eta,1) \, d\eta
- \int_0^{\hat{\eta}} y_E(\eta,0) \, d\eta - \int_{\hat{\eta}}^1 y_D(\eta,0) \, d\eta \geq c.
\]

Two factors determine the profitability of inducing the worker to train, ignoring existence problems. First, the returns depend on \( y_i(\eta,1) - y_i(\eta,0) - c \), the returns to training. A second factor that determines the profitability of this strategy is that if the firm offers
the worker a high wage in job D, it is reluctant to promote him. If \( \eta^* > 0 \), so not everyone is promoted after training, this ex post constraint on the firm’s behavior reduces the probability of promotion below the first best level, where the worker is promoted if \( y_E(\eta, 1) < y_D(\eta, 1) \). See Figure I. The first best level of promotion is given by \( \lambda \). But because \( w_D - w_E > 0 \), a fraction less than \( \lambda \) is promoted. Hence the first best is not possible here if \( \eta^* > 0 \) as workers are inefficiently assigned to jobs.

The only case where the ex post constraint does not bind and so the first best is attainable (ignoring existence problems) is where a contract exists with all workers promoted after training (\( \eta^* = 0 \)). This requires that the firm assigns the worst worker to job D after training; i.e.,

\[
y_D(0, 1) - y_E(0, 1) > w_D - w_E.
\]

But if \( \eta^* = 0 \), \( w_D - w_E = c/\hat{\eta} \) from [WIC] so that \( \hat{\eta} \) is defined by

\[
y_D(\hat{\eta}, 0) - y_E(\hat{\eta}, 0) = c/\hat{\eta}.
\]

In other words, the worst worker must be promoted if he trains, when offered a premium of \( c/\hat{\eta} \) as required from [WIC] when \( \eta^* = 0 \). However, if the firm does not promote the worst worker in equilibrium, [FIC*] binds so that \( y_D(\eta^*, 1) - y_E(\eta^*, 1) = w_D - w_E \); and since \( w_D - w_E > 0 \), this implies that the efficient allocation of workers to jobs is impossible. This yields Proposition 2.

**Proposition 2.** Some workers are inefficiently assigned to jobs if \( \eta^* > 0 \).

It should be stressed that the firm may not induce the worker to train even in some cases where (a) it is possible to do so, and (ii) the productivity increase for any worker in any given job exceeds \( c \). This is caused if the misallocation effect described above is large enough such that (8) is violated. To see the intuition for this, once again consider Figure I. Assume that the optimal contract where the worker trains implies a wage premium of \( \mu \). This implies that the fraction promoted after training is \( \omega \), below the first best level

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8. This was first noted in Waldman [1984].

9. For example, let \( y_E(\eta, s) = (1 + s)/10, y_D(\eta, s) = \eta s \) and \( c = 0.1 \). Then from [WIC], \( (1 - \eta^*)[w_D - w_E] \geq 0.1 \). From [FIC], \( \eta^* - 0.2 = w_D - w_E \). Combining these and letting [WIC] bind, gives the quadratic equation \( (\eta^* - 0.2)(10 - 10\eta^*) = 1 \), which has two positive roots \( \eta^* = 0.345 \) or 0.355. As argued above, \( \eta^* = 0.345 \) is more efficient as this minimizes inefficient allocation of workers to jobs. Note that on efficiency grounds, all above ability \( \eta = 0.2 \) should be promoted. Hence the firm’s ex post constraint implies that fewer are promoted than is efficient.

of $\lambda$. An alternative strategy is not to induce the worker to train by offering $w_D - w_E = 0$. This incurs the obvious potential inefficiency that no training occurs: However, at least it reduces the misallocation of workers to jobs, as a fraction $\rho$ of the workforce is allocated to job D. Hence the misallocation effect may be strong enough for the firm to eschew inducing the worker to train, even if training increases the productivity of all workers by more than $c$.

To briefly summarize, I have shown that the firm can induce the worker to collect firm-specific human capital in some circumstances by promotion to a different task. This is not the first best solution as there will in general be misallocation of workers to jobs. Two ingredients are necessary for the result. First, the firm must be able to commit to a pay scale, where wages are attached to jobs. Second, the returns to training must be higher in one job than the other. (More than this, it must be known by workers that training improves their promotion chances.) If the return to training is identical in both jobs, training has no effect on promotion prospects and so cannot be used as an incentive device. Note finally that if $\eta$ refers to the worker's ability, the worker is only rewarded for collecting skills if he is talented ($\eta > \eta^*$); the less able are not rewarded for collecting skills. Hence issues of sorting and incentives are linked.

III. Conclusion

The classic treatment of human capital is Becker [1964], who analyzes how workers should be compensated for skill collection when firms can monitor skills and can be trusted to repay workers for collecting these skills. In effect, firms and workers can write contracts on skills collected (though not on quit or layoff decisions). In this paper I have argued that the vague nature of many skills collected by workers makes it difficult to directly compensate them to their collection. Instead, subjective evaluation of workers is necessary. However, "without high trust, there is little chance that the subordinate will believe that his pay is fairly based on performance" [Lawler, 1971, p. 171]. I have shown that a resolution of this problem is that firms may offer promotion to another task as an incentive to collect skills.

This is not the only means of encouraging workers to collect nonverifiable specific skills. One possibility is that the firm develops a reputation for honestly repaying workers. But this relies on the firm's discount rate being sufficiently low to make paying
workers for the cost of skills collected today worth the future benefits of a reputation. Furthermore, one possible way of punishing the firm for appropriating the returns to training is that the workers respond by, say, reducing future effort. But in reality it may be difficult for other workers to determine whether a worker has genuinely collected skills or whether the worker has been repaid for doing so. Hence generating a reputation for the "firm" may in reality be difficult.

An alternative solution to the firm's ex post appropriation problem is to run a tournament between workers with a fixed wage bill (see Carmichael [1983] and Malcomson [1984]). Here the prizes in the tournament act as an incentive to workers while the firm sets the wage bill before workers train to overcome its ex post incentive. A drawback of tournaments, however, is that because workers compete for prizes, they are less likely to cooperate with one another [Lazear, 1989]. The solution derived here is unlikely to suffer from this problem. Hence when cooperation is important, the solution described above may dominate tournaments.

Work related to this has been carried out by Kahn and Huberman [1988]. They consider the role of "up-or-out" contracts in encouraging a worker to collect skills. Here after an initial probationary period, a worker either is retained at a prespecified wage or is fired. The underlying idea is similar to that here: (i) the worker's moral hazard problem can be solved by making the return to being retained high enough, and (ii) the firm's moral hazard problem may be solved if the profits from retaining the worker at the higher wage exceed the lost profits caused by layoff. However, according to Baker, Jensen, and Murphy [1988, p 605], "up-or-out policies seem to us a particularly harsh way of dealing with . . . employees," especially as those employees have collected firm-specific skills. Baker et al. continue to note that "up-or-out systems are almost never observed in large multilevel hierarchical organizations. These firms . . . are characterized by strong promotion-based reward schemes." Hence it seems that firms prefer institutional arrangements and compensation schemes more like those derived here than in Kahn and Huberman.

Note, however, that the logic of this paper only holds if workers can be assigned to different tasks, not just job titles. For example, a clerical worker may collect specific skills to become more productive in a managerial position, the productivity of which may be more sensitive to training as it carries more responsibility. Yet for other occupations, such as lawyers, academics, or doctors,
the nature of the work does not appear to vary significantly with
the rank of the employee. As a result, promotion may not act as a
sufficient incentive as the firm has no incentive to promote after
training. For example, a university may have no incentive to
promote a junior faculty member as the nature of the work he does
will not change after promotion, so why incur the extra wage costs?
As a result, this paper suggests that academics, lawyers, and
doctors will not use promotion as the principal means of inducing
the collection of specific skills, but rather will rely on measures
such as up-or-out contracts, as appears to occur in each of these
professions. Only in professions where promotion involves differ-ent tasks will firms use promotion-based incentive schemes.

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