Layoffs as Part of an Optimal Incentive Mix: 
Theory and Evidence

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Abstract

Firms offer highly complex contracts to their employees. These contracts contain a mix of various incentives, such as fixed wages, bonuses, promise of promotion, and threat of firing. This paper aims at explaining the reason why this incentive-mix arises. In particular, the model focuses on why firms are combining promotions and bonuses with firing. The theoretical model proposed is a job-assignment model with heterogeneous employees. In this model the firm is concerned about job assignment, because the overall productivity of the firm depends upon the quality of the employees and their allocation to jobs. The model shows that firing has a dual role. Firing creates incentives for the employees, and it is used as a sorting device that allows the firm to improve workforce quality. Thus, quality-concerned firms might want to combine cost-efficient incentives such as promotions and bonuses with firing. To comply with the Gibbons and Waldman critique, a large set of the model’s broader predictions is stated explicitly and tested on the personnel records from a large pharmaceutical company. The model’s conjectures are shown to be consistent with the data.

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1 Motivation

Firms use a variety of economic incentives. Fixed wages, bonuses, promise of promotion, and threat of firing are the most frequently used ones. In general, economists understand why firms choose to use various incentives, but not why firms would prefer a specific mix. Understanding the reasons why such a mix arises has strong policy implications, besides contributing to our understanding of personnel economics. The reason is that in many markets firing, an important piece of the incentive mix, is constrained. Thus, understanding the economic role of the incentive mix, and in particular the role of firing, provides yet another angle to evaluate the effects of labor-market regulations.

This paper presents a theoretical model of how incentives are used in firms, and provides empirical evidence showing that firms that are concerned about the quality of the workforce, may have strong interests in using firing. Consequently, quality-concerned firms in heavily regulated markets might face comparative disadvantage when competing internationally, because they are forced to undertake second-best personnel policies.

Traditionally, it has been difficult to obtain detailed information on the compensation systems used in firms. Nevertheless, the evidence that firms use a rich set of incentives is accumulating see Medoff and Abraham [1980, 1981]; Baker, Gibbs, and Holmström [1994a,b]; Gibbs [1995]; and Lazear [1992, 2000]. To conduct the present analysis of within firm incentives we have successfully obtained the personnel records from a large pharmaceutical firm, in which the four incentives: fixed wages, bonuses, promise of promotion, and threat of firing are observed. This detailed information, and in particular the observed role of firing, makes these data well-suited to investigate the incentive-mix in a joint theoretical-empirical framework.

Conventional economic theory motivates the use of the different incentive mechanisms in separate frameworks. First, the performance-pay literature, which originates from Mirrlees [1974, 1976] and Holmström [1979, 1982], explains why pay should be linked to output. According to this theory, wages should include variable elements, such as bonuses or piece rate, to reward employee effort. Second, the efficiency-wage literature started off by Shapiro and Stiglitz [1984] emphasizes the incentive-effect of firing, or the threat of firing. Intuitively, if employment involves rents, then the fear of losing the job provides incentives.

Tournament theory, initiated by Lazear and Rosen [1981], integrates the usage of the incentives in a competitive framework. If the number of workers rewarded, fired, or promoted is preset, then workers have an incentive to exert effort. In principle, tournament theory explains why firms would use any element of the mix. Tournament theory cannot explain, however, why the firm would prefer a specific mix of incentives.

MacLeod and Malcolmson [1998] analyze the relative merits of different incentive tools. They contrast efficiency-wage and performance-pay incentives, that is, firing and bonus payments as incentive tools. Under the efficiency wage system, firms pay rents ex-ante, and provide incentives by firing shirking workers. Under the performance-pay regime, firms pay bonuses ex-post, conditional on effort. The model shows that, in general, efficiency-wage incentives are more expensive. Yet, efficiency wage might arise because it gives compensation upfront. Hence, if the firm cannot commit to pay bonuses, then efficiency wages might be the only way to motivate employees. The results, however, do not answer the question why the observed incentive mix can arise. In the MacLeod and Malcolmson [1998] setup, either efficiency wage or performance pay prevails.

Our basic model, which is a traditional principal-agent model with hidden effort, is set in an
indefinitely repeated context. It is shown that the optimal behavior of the firm is to motivate the employees through bonus payments and promotions, but it should not fire employees. Thus, the incentive mix observed in firms does not arise. The reason is that in contrast to promotions and bonus payments, firing is wasteful. Firing is costly both for the firm (recruiting and training of new employees) and for the worker (job search), and in equilibrium the firm shoulders all these costs. Thus, firms prefer to offer promotions and bonuses, over threatening employees with layoffs. This finding of the basic model is consistent with MacLeod and Malcolmson [1998].

The basic model is extended to accommodate employee-heterogeneity. The profit-maximizing firm is now concerned about job assignment, because the overall productivity of the firm depends upon the quality of the employees and their allocation to jobs. These concerns create a trade-off for the firm. Increasing firing induces additional costs on the firm. Firing, however, also increases employee quality. This trade-off explains why the firm might prefer to use the delicate mix of incentives, which is observed in the data.

The paper shows that the incentive-mix, and, in particular, firing, has profound implications for the within-firm dynamics. As a novel feature, these implications are explored by using the optimal steady-state contract to characterize employees' careers. In particular, it is shown that within organizational rank, selection on tenure is not necessarily negative as argued in earlier research by Medoff and Abraham [1980, 1981], Lazear [1992, 2000], Gibbs [1995], and Gibbons and Waldman [1999a,b]. The empirical analysis confirms this theoretical result by providing the first example for positive within organizational rank selection on tenure. This finding shows, as Guasch and Weiss [1980] suggest, that selection constitutes an interesting alternative to on-the-job human-capital acquisition to explain the effects of tenure on earnings. In fact, selection alone can justify a positively sloped earning profile in tenure.

The model’s additional conjectures about the employee’s careers are tested formally in the empirical section of the paper. Contrasting the broad set of conjecture to data is used to comply with the Gibbons and Waldman [1999a,b] critique, namely that many models may be able to explain a single empirical finding (such as the observed incentive mix), but they often fail to explain a broader pattern of empirical evidence. First, it is confirmed that the firm engages in sorting which is a basic assumption of the job assignment model. Second, it is established that the firm has a positive selection, i.e., individuals with higher rank and higher tenure are more likely to be of high-ability. Also, the model’s predictions about earnings dynamics, the likelihood of receiving bonus payments, being promoted and being laid off, are shown to be consistent with the data.

In the next section, the basic model is outlined. Section 3 extends this model to accommodate employee heterogeneity and address the consequences of sorting and selection for the employees’ career evolution. Furthermore, the conjectures of the theoretical model are stated here. The data are presented in section 4, and the close relation between the empirical contract and the theoretical model is emphasized. In section 5, the model’s conjectures are tested empirically. A detailed discussion of the model’s limitations and suggestions for future research takes place in section 6. Finally, section 7 summarizes and concludes.
2 Basic model

The basic model entails the contracting relationship between a risk-neutral firm and a unit volume of risk-neutral employees. The firm and the employees form a principal-agent relationship. The firm maximizes steady-state expected profit, while the employees maximize their expected period utility.\footnote{Focusing on steady-state profits avoids exploring various convergence paths, and computing net-present values along these paths. The assumption that workers maximize period utility means that the firm’s long-term contracting does not entail deferred compensation or ex-ante rents.}

The model is set in an infinitely repeated setup. The timing of events within each period is as outlined below:

1. The period starts.
2. The firm offers a contract.
3. The employees inside the firm accept or decline the contract.
4. Potential employees outside the firm decide on the contract.
5. The employees decide about the effort level.
6. Output is realized and observed by all.
7. Bonuses are paid; employees are promoted or fired.
8. Some employees leave for exogenous reasons.
9. The period starts all over again.

The employees produce probabilistic output, which is normalized to 0 (low) and $C$ (high). The probability that the output is $C$, is $\theta$ and naturally $\theta \in [0,1]$. The employee, once having accepted the job, can influence the probability of high output by exerting effort. The utility cost of effort exertion is $e$, and effort increases the probability of success by $\delta$.\footnote{The IC constraint in the contracting problem secure that all employees exert effort.} We assume that $\theta + \delta < 1$.

The utility of the employee’s alternative job option is denoted by $\bar{U}$. Furthermore, the additional utility of a promotion is $U_p$, and the utility cost from being fired is $U_f$ (note that both parameters are positive). The utility of promotion stems from managerial rents, and is discussed in detail in the appendix. The utility loss from firing reflects that if an employee is laid off, then he or she must search for a new job, which is costly, as there are frictions on the labor market.

The firm sets a stationary contract through the following four parameters: \{w,b,\pi_p,\pi_f\}. First, a fixed wage ($w$) is offered to all individuals who accept the job. The remaining three parameters are conditioned on performance. It is assumed that bonus payments ($b$) are paid to well-performing agents, that the firm considers promoting employees with high observable output (high performance), and considers firing employees with low observed output (low performance). The conditional promotion probability and the conditional firing probability are denoted by $\pi_p$ and $\pi_f$, respectively. The parameters are (realistically) constrained as follows: $w,b \geq 0; \pi_f,\pi_p \in [0,1]$. Conditioning bonus, promotion and firing on output as above can be done without the loss of generality, which can be seen from the discussion in the appendix.
Turnover is costly, as the firm has replacement and training costs. These costs are summarized in the turnover-cost parameter $K$. There are three sources to turnover in the firm. First, the firm can influence turnover by laying off workers. Second, some workers leave the firm for natural reasons, such as retirement or family relocation. The volume of firm-initiated separations is $(1 - \theta - \delta)\pi_P$, and the exogenous natural turnover is denoted by $g \in [0,1]$. Finally, promoted employees must be replaced.

The employees desire promotions, because promotion entails rent. The number of employees who can be promoted is, however, constrained by the number of vacant positions at the management level. That is, the volume of promotions $(\theta + \delta)\pi_P$ is constrained by the volume of exogenous job openings at the managerial level, $g_M \in [0,1]$. Moreover, since the managerial level is smaller than the non-managerial level, the relative size of the two hierarchical levels should be taken into account when considering promotions. For this reason, we denote the size-ratio by $H > 1$. The above argumentation is summarized in the promotion-constraint $(F)$:

$$(\theta + \delta)\pi_P \leq \frac{g_M}{H} \tag{1}$$

The firm has two hierarchical ranks: employees and managers. Managers consist of formerly promoted non-management employees and individuals hired from the external labor market directly into management. These employees contribute to the firm’s profit, with a fixed-value $M$. We assume that $C < M$, that is, managerial output is more important than employee output. This follows from the fact that managers affect the output of multiple non-management employees. The parameters used in the model are summarized in Figure (1).

![Figure 1: Model parameters](image)

In order to keep the analysis tractable, it is assumed that the firm has all the bargaining power. Furthermore, in order to rule out indeterminacies, two tie-breaking rules are imposed.  

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3 $g_M$ captures both firm- and employee-initiated separations at the management level.

4 Later, with job assignment—the firm can adjust managerial output by increasing the quality of the promoted workers. Thus, managerial output will play an important role once employee heterogeneity is accounted for.
First, indifferent players act such that the other player is better off. This can be interpreted as goodwill. Second, if the employees and the firm are equally well-off with different contracts, then the firm chooses the contract that implies the higher fixed wage. This embodies a weak form of commitment-concern, and a very weak form of employee risk-aversion.

Finally, we formally define our interest, the observed incentive mix.

**Definition 1 (Observed incentive mix)** The observed incentive mix arises when the firm strictly prefers to set all the parameters \( \{w,b,\pi_P,\pi_F\} \) to non-zero values.

### 2.1 Contracting problem

The contracting problem is summarized in the following equations:

\[
\max_{w,b,\pi_P,\pi_F} \Pi(w,b,\pi_F,\pi_P) = \max_{w,b,\pi_P,\pi_F} M/H + (\theta + \delta)C - w - (\theta + \delta)b - \left[ (1 - \theta - \delta)\pi_F + g + \frac{gM}{H} \right] K
\]

subject to

\[
\begin{align*}
(\text{IC}) \quad w - c &+ (\theta + \delta)[b + \pi_P U_P] - (1 - \theta - \delta)\pi_F U_F \geq w + \theta[b + \pi_P U_P] - (1 - \theta)\pi_F U_F \\
(\text{IR}) \quad w - e &+ (\theta + \delta)[b + \pi_P U_P] - (1 - \theta - \delta)\pi_F U_F \geq \bar{U} \\
(\text{F}) \quad (\theta + \delta)\pi_P &\leq \frac{gM}{H} \\
\text{non-negativity} &\quad 0 \leq w,b \\
\text{probability} &\quad 0 \leq \pi_F, \pi_P \leq 1
\end{align*}
\]

Intuitively, the program above states that the firm maximizes profit. Each manager contributes to the profit by \( M \), and their number is \( 1/H \). Employees contribute to firm profit by providing the high output \( C \), with probability \( (\theta + \delta) \). In exchange, employees are compensated. The firm pays fixed wages \( (w) \) with certainty, and bonuses \( (b) \) with probability \( (\theta + \delta) \). In addition, the firm has to incur costs of turnover \( (K) \) from three sources. First, the firm fires badly performing employees with probability \( \pi_F \). Second, the firm has to replace the volume \( g \) of employees leaving the non-management level for exogenous reasons. Third, the firm must replace exogenously departing managers \( (gM/H) \). Maximizing this steady-state profit is the objective of the firm.

The \( \text{IC} \)-constraint implies that the employee accepting the contract is better off by exerting the first-best high effort. The left-hand side shows the worker’s utility given effort. The employee receives the fixed wage \( (w) \), and incurs the cost of effort \( (e) \). Furthermore, the probability \( (\theta + \delta) \) of high output leads to a relatively high probability of receiving bonus payments \( (b) \) and promotion \( (\pi_P) \), which provides utility \( (U_P) \). Also, the employee has a lower probability \( (1 - \theta - \delta)\pi_F \) of being fired, and thereby incurring the disutility \( (U_F) \). The right-hand side shows the worker’s compensation without effort-exertion. Here the chances for bonuses and promotions are lower \( (\theta) \), and that of firing \( (1 - \theta)\pi_F \) is higher. Thus, in principle, bonuses, promotions, and firing are used to induce effort.

The \( \text{IR} \)-constraint states that the employee is better off accepting the contract. The left-hand side of the equation is the same as in the \( \text{IC} \)-constraint, i.e., the utility of exerting effort. This utility must exceed the utility of the employee’s outside option \( (\bar{U}) \).
The other constraints follow from the assumptions directly. Wages and bonuses must be non-negative, as the non-negativity constraints say. Finally, conditional firing and promotion probabilities must be on the unit interval.

2.2 Solving the basic model

The model is first solved by assuming that the three incentive constraints \( IR, IC, \) and \( F \) are binding. This implies:

\[
\begin{align*}
  b &= \frac{e}{\delta} - \pi_F U_F - \pi_P U_P \\
  w &= e - (\theta + \delta)[b + \pi_P U_P] + (1 - \theta - \delta)\pi_F U_F + \bar{U} \\
  \pi_P &= \frac{gM}{H(\theta + \delta)}
\end{align*}
\]

As there are four parameters to set the contract, choosing a single parameter (let’s say the firing parameter) determines the contract through these three equations. Consequently, the original four-parameter incentive problem is reduced to a single-parameter optimization. Expressing the profit as a function of \( \pi_F \), the first-order condition reveals that the objective function is maximized when the firing rate is minimized. The intuition is that firing is more costly than bonuses to motivate workers. Firing creates two social costs: cost of hiring and utility loss of firing. In equilibrium, these two costs are born by the firm. Lemma (1) summarizes the result. The proof of the lemma is provided in the appendix as well as the proof of other statements.

**Lemma 1** If the IR, IC, and F constraints are binding, then incentives are given through bonuses and promotions, but not through firing. Thus, the observed incentive-mix does not arise.

Moreover, even if the constraints are not binding, the observed incentive-mix does not arise in the optimal contract. The intuition for the result follows simply from profit maximization. If the no-slack condition on promotion-probability (5) is violated in a profit-maximizing context, then promotion in itself provides sufficient incentives, and both firing and bonuses are set to zero. If the condition on bonuses (3) is satisfied with slack, then, by definition, the bonus must be zero (or else it could be reduced). Finally, if the condition on wage (4) is satisfied with a slack, then the wage must be zero (or else, again, it could be profitably reduced).

**Remark 1** If the optimal solution involves incentive-slack (at least one of the IR-, IC- and F-constraints is not binding), then it is optimal for the firm to set either bonuses, or fixed wages equal to zero. Thus, even with incentive-slack, the observed incentive-mix cannot arise.

The results of the basic model also can be interpreted as evidence for a hierarchy of incentives. The firm prefers to use promotions, because they exploit costless residual rents. If additional incentives are needed (to satisfy the IC-constraint), then the firm turns to using bonuses. Finally, to ensure worker participation (and satisfy the IR-constraint), the firm uses fixed wages, but only if bonuses and promotions are insufficient. Firing, however, is never used, because of its cost-disadvantage.

Finally, a few words about rents in the model. There is no ex-ante rent by assumption (and thus the individual rationality constraint \( IR \) is binding). However, the fact that firing causes disutilities \( (U_F) \) shows that interim there is rent. The interpretation is, that even though the worker initially is
indifferent between the firm’s offer and other offers, going back to the labor market and continuing to search is costly. Thus, interim, there is rent from retaining the job, and the firm can exploit this feature to motivate the worker. Lemma (1) states, however, that motivating through layoffs is more costly than motivating through bonus payments.

3 Job-assignment model

In this section, the basic model is extended to accommodate employee heterogeneity. The profit-maximizing firm is now concerned about job assignment, because the quality of the workforce and the allocation of employees to jobs (non-management vs. management jobs) are important for the firm’s overall productivity. This implies that the firm has an additional motivation (besides incentive purposes) to promote and to lay off employees, as the two devices can be used to adjust the quality of the workforce at both hierarchical levels.

The job-assignment model is used for two purposes. First, it is shown that sorting and selection considerations lead to the optimal incentive mix. Second, the model is utilized to characterize the career path of individual employees. This proves to be useful for testing the model’s predictions.

3.1 The observed incentive mix

Potential employees are heterogeneous. There are good employees \( G \), with high ability, and bad ones \( B \), with low ability. The good employees are more likely to produce a high output, as compared with the bad employees, i.e., \( \theta_G > \theta_B \). However, the ability of the employee cannot be observed, by either the employee or the firm. Consequently, employees (both good- and bad-ability ones) face a single outside option, providing utility \( \bar{U} \).

The firm’s external labor market consists of a proportion \( \mu \) of high-ability individuals. Since the firm can use promotions and layoffs to sort and select employees, their composition in the firm’s internal labor market can differ from the composition in the external labor market. For this reason, the proportion of high-ability types in the beginning of the period at the non-management level of the firm is denoted by \( \mu_F \), and the proportion of high-ability types at the management level is denoted by \( \mu_M \).

3.1.1 The period problem

In each period, the same contracting problem is repeated.\(^5\) However, as employees do not know their ability ex-ante, the firm is unable to write a contract to elicit self-selection ex-ante. Thus, a pooling equilibrium arises. The contracting problem of the pooling equilibrium can be summarized as follows.\(^6\)

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\(^5\) The model continues to use the action set laid out in the basic model. Yet, there is a valid concern that the action set limits the firm to select the best and weed out the worst employees. In particular, the firm could condition promotion and firing on a longer history of output. This concern is well-understood, and it is discussed in the appendix. In the appendix it is shown that the model’s main prediction does not change with learning from output history. Thus, in order to keep the exposition tractable and intuitive we continue the analysis with the original action set.

\(^6\) Note, that although the profit depends on \( \mu_F \), it is taken for granted, since the firm cannot control the composition of the workers within the period.
Remark 2 If the considerations outweigh quality concerns, then the promotion probability is that the managerial rent becomes increasingly worse. In addition, it reduces the average productivity of the non-management level. This has the implication that the pool from which the promotions from inside, but internal promotions decrease the quality of the workforce pool at the non-management employees. Consequently, one cannot assume in general that the Piore [1971], this corresponds to identifying conditions under which the or exclusively from inside to the managerial level. Using the terminology from Doeringer and Piore [1971], this constraint arises, as the two possible constraints are binding, then the following equalities will hold:

\[
\begin{align*}
\Pi(w,b,\pi_F,\pi_P) &= \max_{w,b,\pi_F,\pi_P} \frac{M\mu_F^M}{H} + \mu_F(\theta_G + \delta)(C - b) \\
&+ (1 - \mu_F)(\theta_B + \delta)(C - b) - w - \mu_F(1 - \theta_G - \delta)\pi_F K \\
&- (1 - \mu_F)(1 - \theta_B - \delta)\pi_F K -(g + \frac{gM}{H})K
\end{align*}
\]

subject to

\[
\begin{align*}
(I C) & \quad \delta[b + \pi_F U_P] + \delta\pi_F U_F \geq e \\
(IR) & \quad w - e + (\theta_G + \delta)[b + \pi_P U_P] - (1 - \theta_G - \delta)\pi_F U_P \geq \hat{U} \\
(F) & \quad \mu_F \theta_G + (1 - \mu_F)\theta_B + \delta)\pi_P \leq \frac{gM}{H} \\
\text{non-negativity} & \quad 0 \leq b \\
\text{probability} & \quad 0 \leq \pi_F, \pi_P \leq 1
\end{align*}
\]

If the IC and the IR constraints are binding, then the following equalities will hold:

\[
\begin{align*}
b &= \frac{e}{\delta} - \pi_F U_F - \pi_P U_P \\
w &= e - (\theta_G + \delta)[b + \pi_P U_P] + (1 - \theta_G - \delta)\pi_F U_F + \hat{U}
\end{align*}
\]

It is not trivial, however, that the F constraint is binding. Incentive considerations support promotions from inside, but internal promotions decrease the quality of the workforce pool at the non-management level. This has the implication that the pool from which the firm can promote in the future becomes increasingly worse. In addition, it reduces the average productivity of the non-management employees. Consequently, one cannot assume in general that the F constraint holds without slack, which is a significant deviation from the basic model.

Nevertheless, it is possible to show conditions under which the firm prefers to promote mostly or exclusively from inside to the managerial level. Using the terminology from Doeringer and Piore [1971], this corresponds to identifying conditions under which the firm has ports of entry. In this context, it can be shown that if the managerial rent (\(U_P\)) is sufficiently high, then incentive considerations outweigh quality concerns.

Remark 2 If the profit is increasing differentially in the promotion probability, namely,

\[
\frac{\partial \Pi}{\partial \pi_P} > 0,
\]

then the firm has ports of entry, and the F-constraint binds. A sufficient condition for the above promotion probability is that the managerial rent (\(U_P\)) from promotion is sufficiently high.

\footnote{The single IC constraint arises, as the two possible IC constraints (for bad and good types) can be simplified to a single equation above:

\[
\begin{align*}
(I C_G) & \quad w - e + (\theta_G + \delta)[b + \pi_P U_P] - (1 - \theta_G - \delta)\pi_F U_P \geq w + \theta_G[b + \pi_P U_P] - (1 - \theta_G)\pi_F U_F \\
(I C_B) & \quad w - e + (\theta_B + \delta)[b + \pi_P U_P] - (1 - \theta_B - \delta)\pi_F U_P \geq w + \theta_B[b + \pi_P U_P] - (1 - \theta_B)\pi_F U_F
\end{align*}
\]
3.1.2 Steady-state equilibrium

In contrast to the homogenous-employee case, the one-period problem alone does not solve the infinitely repeated problem. The reason is that in the one-period game, the equilibrium employee composition is undetermined. In order to solve this endogenously, the steady-state equilibrium is explored. That is, if the firm applies a stationary firing and promotion policy, then the workforce composition will converge to a steady-state value. This steady-state value is determined in Lemma (2).

**Lemma 2** In steady state, the equilibrium proportion of good workers ($\mu_F^*$) in the non-management level depends on the firing and promotion probabilities:

$$
\mu_F^* = \mu \frac{(1 - \theta_B - \delta)\pi_F + g}{(1 - \theta_G - \delta)\pi_F + \mu(\theta_G - \theta_B)\pi_F + (\theta_G + \delta)\pi_P + g}
$$

Moreover, the proportion of good quality workers at the managerial level can be determined in steady-state equilibrium.

$$
\mu_H^* = \frac{\pi_P \mu_F^*(\theta_G + \delta) + \left(\frac{g_M}{H(\mu_P^*\theta_G + (1 - \mu_F^*)\theta_B + \delta)} - \pi_P\right)\mu}{\pi_P(\delta + \mu_F^*(\theta_G - \theta_B) + \theta_B) + \left(\frac{g_M}{H(\mu_P^*\theta_G + (1 - \mu_F^*)\theta_B + \delta)} - \pi_P\right)\mu}
$$

Lemma (2) allows for some comparative statistics. It follows from equation (7) that increasing internal promotions decreases the equilibrium quality of non-management employees. Increasing firing, however, has the opposite effect. Equation (8) shows the role of internal promotions and external hiring. For instance, the better the pool of internal non-management employees is, the worse is the effect of external hiring on managerial quality.

3.1.3 Simulating the optimal incentive mix

With these results at hand, the equilibrium steady-state profit levels can be simulated as a function of the firing parameter and the promotion parameter. Note that direct substitution back to (6) is not possible, as $\mu_F^*$ and $\pi_P$ are jointly determined. Nevertheless, it is straightforward to simulate the behavior of the profit function see [Figure 2]. It is obvious from the left-hand-side graph that the optimal policy for the firm is to promote as many individuals as possible, i.e., $\pi_P^* > 0$. The right-hand-side graph illustrates the profit as a function of $\pi_P$ conditional on the highest possible promotion rate. Clearly, the optimal level of firing is non-zero, i.e., $\pi_F^* > 0$. Given $\pi_P^*$ and $\pi_F^*$, it follows that $w^*, b^* > 0$. Hence, it is optimal for the firm to offer a contract that involves fixed wages, bonuses, promotions, and firing. This is the optimal incentive mix observed in firms. Lemma (3) summarizes the result of the simulation.

**Lemma 3** In the job-assignment model, an optimal incentive mix of fixed wages, bonuses, promotions, and firing can arise in equilibrium.

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*The parameters used: $\mu = .4$, $\theta_G = .5$, $\theta_B = .2$, $\delta = .2$, $C = 9$, $H = 25$, $K = 3$, $e = .85$, $g = .6\%$, $g' = 2\%$, $U_F = 1$, $U_P = 1$, $U_G = 2$, $M = 25$. In equilibrium, the incentive mix is: $\pi_F = 3.25\%$, $\pi_P = .15\%$, $w = .9075$, $b = 4.2185$ (note: values are rounded).*

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3.2 Characterizing employee careers

In the above discussion, it is established that in a firm where the optimal contract involves paying an incentive mix, composition and allocation of the workforce is important for profit maximization. We used Lemma (2) to establish the relation between the firm’s choice of firing and promotion probabilities and the steady-state composition of the workforce. Lemma (2), however, is silent about the consequences of these policies for individual workers. This section investigates these implications in a firm with ports of entry (that is binding \( F \)-constraint).9

Promotions and layoffs affect the firm’s selection scheme. As these decisions are based on employee performance, they have different consequences for high- and low-ability employees. In particular, for the high-ability worker, the probability of being fired in any given period is \((1 - \theta_G - \delta)\pi_F\), and for the low-ability worker, the probability is \((1 - \theta_B - \delta)\pi_F\). Hence, it is more likely that the bad worker loses his job. By the same logic, good workers are more likely to be promoted, as \((\theta_G + \delta)\pi_P > (\theta_B + \delta)\pi_P\).

This allows for investigating the effects of the optimal contract on selection in rank and tenure. Selection on rank is always positive, as well-performing agents, who are more likely to be of good quality than the average employee, are promoted. Selection on tenure depends upon the relative strength of firing and promotion. Firing weeds out the low-ability employees, whereas promotions weed out the high-ability employees from the non-management ranks. These results are formalized in Lemma (4).

**Lemma 4** With ports of entry: The selection process in the firm is positive in rank (conditional on tenure). Selection on tenure (conditional on rank) is negative if

\[ \pi_P > \pi_F, \]

9 The firm studied in this paper makes use of a high degree of internal managerial hirings (i.e., we observe ports of entry). This motivates the theoretical focus.
and positive if

\[ \pi_F < \pi_P. \]

Previous studies have analyzed the selection mechanism Medoff and Abraham [1980, 1981], Lazear [1992], Gibbs [1995], and Gibbons and Waldman [1999b]. For instance, based on a series of empirical findings, Medoff and Abraham [1980, 1981] write "... the negative within-grade-level correlation which we suspect exists between experience and ability." Lazear [1992] continues this discussion, arguing that "Individuals who remain on the job longer, do worse than those who are promoted out early. Wages actually decline with job tenure, probably reflecting the fall in the average worker’s quality with length of time in the job". In the context of our model, it is clear that if only selection due to promotions is at work, the quality of the workforce that is passed over for promotion will decline with tenure. The optimal contract, however, shows that the firm has incentives to lay off a proportion of the low-performing workers each period. That this behavior affects the selection process is a point that is often missed in the literature. Gibbs [1995] comes closest to this point, and concludes that "... employees are continuously selected out through promotions, demotions, or exits. Because of these selection effects, ability of the group should decline with tenure..."

From this discussion, it is clear that negative selection on tenure is a possibility, but not the rule. If the firing probability exceeds the promotion probability, the selection scheme in tenure shifts from negative to positive. As it will turn out in the empirical analysis conducted below, our firm has a positive selection on tenure (conditional on rank), which provides a counterexample to the earlier conclusions drawn about negative within-rank employee selection.

Bonus payments can be used to test for selection in the firm. A basic assumption of the model is that the firm rewards high performance with bonuses. Thus, the firm’s selection scheme has direct consequences for the way bonuses are paid to the individuals. For instance, in the positive selection case, the probability of being high-ability is increasing in tenure and rank, and thus the probability of receiving bonuses is also increasing in tenure and rank. If the firm has a negative selection, the probability of receiving bonuses would only increase in rank. These results are summarized in Corollary (1).

**Corollary 1** The probability of receiving bonus payments is increasing in rank (conditional on tenure). Furthermore, it is increasing in tenure (conditional on rank), if and only if the firm has a positive selection on tenure.

Selection also affects earnings in tenure. The absence of learning and human-capital acquisition in the model, and the fact that the individual’s external option (\(\bar{U}\)) is time-unvarying imply that the fixed wage in the contract is constant. Yet the combination of an increasing likelihood of receiving bonuses and the flat-wage tenure profile leads to an increasing earnings-tenure profile.\(^{10}\) Corollary (2) summarizes the result.

**Corollary 2** If the firm has a positive selection on tenure, then the within-rank expected-earnings tenure profile is increasing.

\(^{10}\) The flat-wage-tenure profile is an obvious drawback of the pure job-assignment model. For this reason, potential extensions to integrative models, where the job-assignment model is combined with on-the-job human-capital acquisition and learning are discussed below.
3.2.1 The firm’s choice of selection regime

Corollaries (1) and (2) show that employee sorting is important, not only for the observed incentive mix to be an optimal contract, but also because the selection regime predicts the outcome of other key variables in the firm. This makes it interesting to understand what components in the underlying market structure will lead to a particular selection regime. In this context, it is important to recognize that it is the relative magnitude of the firing and the promotion parameters that determines the selection scheme. This is the message from Lemma (4). In general, it is more likely that the firm will have positive selection, if firing is relatively common and promotions are relatively rare.

First, the quality difference between the high- and the low-ability individuals \((\theta_G - \theta_B)\) affects the firm’s choice of selection scheme. The reason is that a large difference will make it profitable for the firm to fire more workers each period, as the quality composition of the workforce has a stronger effect on profits. Thus, large quality differences make positive selection on tenure more likely.

Second, the social costs of firing \((U_F \text{ and } K)\) have a negative effect on the firing rate. Hence, it reduces the likelihood of positive selection. This follows from the fact that the firm shoulders all the costs of turnover in equilibrium. A reduction of these costs, however, implies that the firm can rely more on firing, both for sorting and incentive purposes. Bringing the argument to the extreme, i.e., a situation where firing is socially costless \((U_F = K = 0)\), the efficiency advantage of the performance-pay solution actually vanishes. Thus, in this situation firing would be an equally efficient device to motivate employees, and in addition it will contribute to sorting. Consequently, firing would then dominate bonus payments.

Also, the level of exogenous turnover affects the policy of the firm. When the exogenous turnover at the managerial level \((g_M)\) goes up, the promotion probability increases, due to the binding \(F\)-constraint. This will make negative selection on tenure more likely. A different argument applies to an increase in the exogenous turnover at the non-management level \((g)\). When non-management employees are more likely to leave for exogenous reasons, it increases the firm’s costs to improve on the equilibrium employee composition \((\mu^*_F)\). Since firing is less cost-efficient, it will then be reduced, which increases the likelihood of negative selection.

This discussion indicates that employee quality issues and variation in the cost of firing, or the level of exogenous turnover, are important determinants for the firm’s choice of selection scheme. Variation in these parameters across time, sectors, and economies will be useful predictors for the type of selection that will be observed in firms.

3.3 Empirical predictions

Besides producing the optimal incentive mix the model provides additional empirical predictions. These predictions are outlined in the conjectures below, and will be tested empirically in the following sections. The conjectures are derived directly from the basic assumptions of the model and its lemmas, so they are not proven formally again.

**Conjecture 1 (Sorting)**: Sorting is a necessary condition for the observed incentive-mix of fixed wages, bonuses, promotions, and firing to be an optimal contract.
Conjecture 2 (Selection) With ports of entry: The firm has a positive selection on rank (conditional on tenure). Furthermore, it has a positive selection on tenure (conditional on rank), if and only if $\pi_F > \pi_P$. Otherwise, it has a negative selection on tenure.

Conjecture 3 (Bonus) The probability of receiving a bonus depends positively upon the employees’ ability. Thus, with ports of entry, the likelihood of receiving a bonus increases in rank. Furthermore, the probability of receiving a bonus is increasing in tenure, if and only if the firm has a positive selection on tenure.

Conjecture 4 (Earnings) The within-rank earnings profile (fixed wages plus bonus) is increasing, if and only if the firm has a positive selection on tenure. Otherwise, it is declining.

Conjecture 5 (Promotion) The likelihood of being promoted depends positively, upon the employees’ ability. Thus, the probability of being promoted increases in tenure, if and only if the firm has a positive selection on tenure.

Conjecture 6 (Firing) The likelihood of being fired depends negatively upon the employees’ ability. Thus, the probability of being fired declines in tenure, if and only if the firm has a positive selection on tenure.

4 Data

Four years of monthly personnel records from the main production site of an international pharmaceutical company are used in the empirical analysis.\textsuperscript{11} Average full-time employment in the firm over the period 1997 to 2000 is 5055 persons.\textsuperscript{12} These workers are distributed across four hierarchical levels, ranging from CEO to non-management see Figure 3. The share of management workers in the firm is 4.75 percent, on average, over the four years.

The analysis given below uses only those individuals who participate in the performance-pay system, i.e., the employees who, besides their base salary, can get a bonus, given sufficiently high performance evaluations. The distinction between strictly fixed paid employees, and employees having bonus options, can be made by looking at the worker’s job category. This exercise reveals that the group of fixed-paid employees constitutes 36.96 percent of the workforce, and that it mainly consists of production workers.

The characteristics of the employees calculated from the monthly employee-based observations are presented in the second and third columns of Figure 4. On average, the employees included in the analysis, i.e., those who participate in the performance-pay system (column 3), have 8.90 years of tenure. The same group of individuals consists of 60.60 percent women, and the average age is 39.51 years.

The level of education in the firm is high. In fact, 21.9 percent of the employees have at least a master’s degree, and 11.7 percent have a degree that corresponds to a bachelor’s degree in duration.

\textsuperscript{11}The study is conducted on monthly observations, in contrast to yearly observations. The main motivation for doing this is that the timing of events within a year proves to be important. In the regression results presented below, a “correction” for the use of high-frequency data is made by using clustered standard errors.

\textsuperscript{12}The analysis is focused on permanent full-time employment, which corresponds to 92.66 percent of all individuals employed on the production site.
Only 12.5 percent of the labor force is unskilled.\textsuperscript{13} There are three reasons why this structure is observed. First, the firm is operating in an industry where product development is essential for survival. Hence, a large proportion of the workforce is engaged in research and development. Second, production is highly automated, suggesting that low-skilled labor has been substituted by capital. Finally, in order to comply with the regulations from the Food and Drug Administration (FDA), extensive quality-control programs are implemented, which require skilled labor.

\section*{4.1 The empirical contract, and the theoretical assumptions}

According to the firm’s official remuneration principles, it offers wages to the employee such that: "The base salary is a competitive pay for job function, responsibilities and competencies." The data provide evidence for the fact that this principle is taken seriously. For instance, a preliminary analysis of the fixed-wage component reveals that a set of individual characteristics and information about the employee’s job category predicts wages precisely ($R^2 = 0.852$).

The close relationship between credentials and wages indicates that the wage is fixed, and virtually independent of current employee performance. Instead, individuals are rewarded for actual performance through a bonus system. The allocation of bonuses fulfills the criteria that: "The principles, criteria and targets that will lead to bonus payments should be known by the relevant employee subgroup." The size of the bonus pool varies across the different employee subgroups, and constitutes 2.5 to 4 percent of the wage sum for non-management workers, and 8 percent for non-executive managers.\textsuperscript{14} The bonus system is widespread, and according to the data, 24 percent of workers in non-management receive bonus payments in a given year. The numbers are closer to 75 and 80 percent for managers and vice-presidents, respectively.

The institutional settings impose no restriction on who to fire, and the firm seems to use firing

\textsuperscript{13}Information on education is missing for 8.21 percent of the employees. However, for the group of employees receiving performance pay, only 2.84 percent have missing information on education.

\textsuperscript{14}The subsequent analysis is based on non-management employees, managers, and vice-presidents. The executive management is omitted, due to lack of data.
Table 1: Mean (standard deviations)

<table>
<thead>
<tr>
<th></th>
<th>All employees</th>
<th>Employees participating in the performance pay system</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Observations = 241,951</td>
<td>Observations = 147,558</td>
</tr>
<tr>
<td>Age</td>
<td>39.746</td>
<td>39.505</td>
</tr>
<tr>
<td></td>
<td>(9.125)</td>
<td>(8.541)</td>
</tr>
<tr>
<td>Gender (women = 1)</td>
<td>0.566</td>
<td>0.606</td>
</tr>
<tr>
<td>Unskilled</td>
<td>0.125</td>
<td>0.035</td>
</tr>
<tr>
<td>Skilled worker</td>
<td>0.266</td>
<td>0.159</td>
</tr>
<tr>
<td>Short theoretical education</td>
<td>0.190</td>
<td>0.280</td>
</tr>
<tr>
<td>Bachelor degree</td>
<td>0.117</td>
<td>0.174</td>
</tr>
<tr>
<td>Masters or PhD degree</td>
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</tr>
<tr>
<td>Tenure less than 2 years</td>
<td>0.126</td>
<td>0.119</td>
</tr>
<tr>
<td>Tenure 2 to 5 years</td>
<td>0.303</td>
<td>0.289</td>
</tr>
<tr>
<td>Tenure 6 to 10 years</td>
<td>0.273</td>
<td>0.257</td>
</tr>
<tr>
<td>Tenure above 10 years</td>
<td>0.299</td>
<td>0.334</td>
</tr>
</tbody>
</table>

Figure 4: Descriptive statistics

frequently. The firm’s yearly separation rate is 10.96 percent. The turnover is costly for the firm, but nevertheless, 12.64 percent of all separations are initiated by the firm through layoffs. The separation rate for the employees participating in the performance-pay system is 6.64 percent. Of these, 19.46 (!) percent are initiated by the firm. Thus, firing is a significant component of the observed incentive mix.

There are two motivations for laying off workers. First, the firm’s official wage strategy is to: "Offer attractive salary and employment conditions" in order to "attract, develop and retain qualified employees." Given the "attractive" wages, the firm can use the threat of a layoff to motivate the workers. Second, the layoffs serve as a sorting device, where a proportion of the employees with low performers are forced to separate from the firm in each period. Hence, in a pooling equilibrium where both high- and low-ability workers are employed by the firm, layoffs can be used to control the worker composition.

Finally, the firm has ports of entry. This claim is based on the observation that 98.22 percent of the employees are hired into the lowest hierarchical level. One implication of ports of entry is that management vacancies are filled with incumbent employees. Naturally this policy serves both sorting and incentive purposes. The wage premium (unconditional on human capital) associated with a promotion from non-management and into lower-and middle-management are 52.46 percent and 85.65 percent, respectively.

In the presentation of the firm, it becomes clear that the contract offered to the workers is highly complex in nature. First, the firm pays fixed wages to all workers who accept the contract, 15 All workers in the firm have defined contribution pension plans, hence a layoff will not change the value of the current pension account. In other firms, where workers have defined benefit pension plans, the costs of a layoff in terms of lost pension may be significant. This effect could potentially create large incentives in other firms.
unconditional on performance. Second, 63 percent of the employees can be rewarded for performance through a bonus system. Third, even though turnover is costly for the firm, a significant part of separations is firm-initiated, i.e., layoffs. Finally, the firm has ports of entry, which implies that promotions to higher-level jobs take place (mainly) from the pool of incumbent employees. In sum, the data describes a contract that contains four incentive parameters: $w$, $b$, $\pi_P$, and $\pi_F$.

5 Empirical analysis

The conjectures stated above will be tested empirically in this section. A first goal is to establish that the firm is sorting its employees. According to the job-assignment model, this is a necessary condition for the observed incentive mix to be an optimal contract. Secondly, the firm’s selection scheme is identified to be positive in rank and tenure. This information provides predictions about other key variables in the firm, such as earnings growth, bonus payments, firing, and promotions. For this reason, a test of the model’s broader predictions will be conducted in the final part of the analysis.

Conjecture (1) stated that employee sorting is a necessary condition for the incentive mix to be an optimal contract. Preliminary evidence for sorting is found in the description of the empirical contract where it is established that layoffs and promotions are common in the firm, i.e., $\pi_P, \pi_F > 0$. The presence of layoffs and promotions are necessary conditions for sorting, but are not sufficient in the sense that random decisions would produce no sorting. Thus, a first test for the presence of sorting is to investigate whether the firm makes random decisions, or whether it bases its decisions on information about the employee’s expected ability (such as revealed performance). The measure of performance that will be used in the analysis is bonus payments.$^{16}$

To establish that the firm is sorting, a multinomial logit model is estimated. In the model, the individual is facing the three options: stay within rank, promotion, and, layoff.$^{17}$ The point estimates of a multinomial logit are difficult to interpret, and, hence, the results of the model are evaluated using its predictions.$^{18}$ The effect of a bonus payment on the transition probabilities is presented in Figure 5. A person who receives a bonus payment (i.e., who’s had high performance) has a 0.136 percent chance of being promoted in a given month, while the layoff probability is as low as 0.030 percent. In contrast, a person who did not receive a bonus payment (low performance) has little chance of being promoted, and faces a 0.270 percent risk of being laid off from the firm in any given month.$^{19}$ Hence, a bonus payment increases the promotion probability, with 0.073, percent and reduces the firing probability, with 0.240 percent. This is clear evidence for the fact that the firing and promotion decisions are based on employee performance, meaning the firm is consciously sorting its employees.

Conjecture (2) gave conditions when sorting is positive or negative. They can be tested from the empirical evidence presented in Figure 5. First, the results reveal that high-performance employees are relatively more likely to be promoted. Since high-ability individuals are more likely to have

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$^{16}$Bonuses paid to the individual during the preceding 12 months are used as an indicator for performance, i.e., if the individual received a bonus payment in the period, he or she must have had high performance.

$^{17}$It should be noted that the individuals who separate for natural causes, such as retirement or death, and the individuals who leave the firm for a new job have been deleted from the sample.

$^{18}$The full regression results of the multinomial logit can be seen in Figure (11) in the appendix.

$^{19}$The unconditional yearly promotion probability in the firm is 1.33 percent. In comparison, Lazear (1992) observes a yearly promotion probability close to 2 percent.
a high performance, this finding provides evidence for a selection scheme that is positive on rank. Second, the conditional layoff probability ($\pi_F = 0.270$ percent) exceeds the conditional promotion probability ($\pi_P = 0.136$ percent). According to Lemma (4), this implies a positive selection on tenure.

Moreover, the positive selection might be even stronger than shown by these numbers, due to a bias in the layoff data. A bias arises in the case where the firm is signaling to the worker that the employment relation will end in the near future. This signal will make the worker look for alternative employment, which may be obtained before the firm terminates the match. From conversations with the firm, we have reason to believe that this procedure is common. The implication is that the layoffs observed in the firm only constitute a lower bound on the separations, that, in reality are layoffs.\(^{20}\)

Conjecture (3) focuses on bonus payments. Since the likelihood of receiving bonuses depends upon employee ability, the selection scheme used by the firm, and the probability of receiving a bonus are closely linked (see Corollary 1). One consequence of the positive selection identified in the firm is that more able workers in general will have longer tenure, and will be assigned to higher-rank jobs. Hence, with positive selection, employees who have longer job tenure and who are located at higher ranks (conditional on tenure) will be more likely to receive bonus payments. This observation provides a first test for the model’s broader predictions.

Figure 6 presents logit regressions for the probability of having received a bonus payment during the preceding year. In the first model, tenure and rank are included as explanatory variables, together with dummies for job category and time. As expected, both tenure and rank have significantly positive effects on the probability of receiving bonuses. Furthermore, the results are robust to the inclusion of information on demography (age categories and gender), as seen in model 2.

In model 3, information on education is added. The positive relation between educational attainment and ability, and the increased production capacity of educated workers, implies that workers with higher levels of schooling will be more likely to receive bonus payments see Becker

\(^{20}\)For the sake of completeness, we remark here that selection might get weakened by employee-initiated turnover. High-ability employees, who are underappreciated, might leave the firm for better offers. This, however, does not seem to be a serious problem, as it would require outside firms to have systematically better information than the current employer. It seems, then, that employee-initiated endogenous turnover (if any) is about terminating a bad match, rather than about ability.
[1964]. This result is confirmed by the data. Important for the analysis, however, is to note that the positive effects of tenure and rank on the probability of receiving bonuses survive in model 3. This indicates that ability is signaled only partially through education. Thus, sorting and selection considerations are important, even though the level of formal schooling is observed.\footnote{The tenure-effect identified in Figure (6) could, in principle, be driven by the fact that managerial employees, who, in general, have longer tenure, are more likely to receive bonuses. For this reason, model (3) has been estimated for the non-management employees only. The results show that the tenure effect is robust.}

<table>
<thead>
<tr>
<th>(1) Logit model</th>
<th>(2) Logit model</th>
<th>(3) Logit model</th>
<th>(4) Fixed-effects Logit model</th>
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<tbody>
<tr>
<td>Constant</td>
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<td>-1.524</td>
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<tr>
<td>(0.056)</td>
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<tr>
<td>Tenure less than 2 years</td>
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<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Tenure 2 to 5 years</td>
<td>0.705</td>
<td>0.698</td>
<td>0.696</td>
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<td>(0.058)</td>
<td>(0.058)</td>
<td>(0.059)</td>
<td>(0.098)</td>
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<td>Tenure 6 to 10 years</td>
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<td>(0.059)</td>
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<td>(0.079)</td>
<td>(0.079)</td>
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<td>-</td>
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<tr>
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<td>(0.152)</td>
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<td>(0.329)</td>
<td>(0.328)</td>
<td>(0.898)</td>
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<tr>
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<td>-7996</td>
<td>-7986</td>
</tr>
<tr>
<td># observations</td>
<td>13704</td>
<td>13704</td>
<td>13704</td>
</tr>
</tbody>
</table>

Note: Standard errors are clustered with respect to individuals in models 1 to 3.

Figure 6: Logit regression for bonus payments

An additional test for the relation between tenure and bonus is conducted by estimating a model similar to model 3 in Figure 6, with the tenure categories substituted for yearly tenure dummies (detailed results are not shown).\footnote{The maximum level of tenure in the firm is 44 years, but less than 3.25 percent of the employees have a tenure above 25 years, causing large standard errors on the point estimates of the tenure dummies exceeding the 25th year.} Figure 7 illustrates the cross-sectional effect of tenure on the likelihood of receiving a bonus for the first 25 years of tenure. In accordance with the predictions from positive sorting, the effect is increasing. Thus, the steady increase in the likelihood of receiving bonuses is confirmed by the data.
Figure 7: Tenure-effect on the likelihood of receiving bonus payments

Bonuses during the first many years of employment reflects that sorting and selection are integrated parts of the firm’s policy.

Finally, the cross-sectional relation between the probability of getting a bonus and tenure could arise if a bonus is paid for tenure, and not for performance, as we argue in the model. For this reason, a fixed-effects model, where the individual’s ability is "conditioned out" is estimated, model 4 in Figure 6. In this model, the tenure effect is insignificant, reflecting that ability, and not tenure, determines the probability of receiving bonus payments. This finding allows us to conclude that the increasing cross-sectional bonus-tenure profile observed in the data is driven by positive selection.23

Conjecture (4) describes the within-rank earnings-tenure profile. The prediction from the job-assignment model is that positive selection will lead to an increasing earnings profile. Tests of this hypothesis are presented in Figure 8. In the first model, it is established that earnings are increasing in both tenure and rank. These results are robust to the inclusion of information on demography (age and gender) and education (see model 2). Even though these findings support the hypothesis of an increasing within-rank earnings-tenure profile, the earnings dynamics constitute the Achilles’ heel of the job-assignment model. The reason is that in the model, the shape of the earnings profile is motivated only through the increased likelihood of receiving bonus payments. The data, however, shows that not only the likelihood of bonus payments, but also the fixed-wage component, increases.

23 The models presented in the table provide detailed evidence of the tenure effect on bonus payments due to the inclusion of the seven tenure categories. The details come at the cost, however, that the standard errors for each tenure group becomes fairly high, and may question whether the groups are significantly different or not. To anticipate this criticism, the appendix (Figure 12) provides estimates of models similar to those presented in Figure 6, but where the category dummies are substituted for a linear tenure effect. These regressions show that the tenure-effect is highly significant and positive in the cross-sectional models, and insignificant in the fixed-effects models. Hence, they resemble the results of the table. The regressions also show that these results are not driven by the very low probability of getting bonus payments for newly hired employees (whose tenure is less than one or two years).
in tenure. In the next section, it will be discussed how the job-assignment model can be changed or extended to accommodate these fixed-wage dynamics. For now, these dynamics are disregarded.

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*Note: Standard errors are clustered with respect to individuals.*

Figure 8: Mincer earnings regressions.

Conjectures (5) and (6) state the model’s predictions on promotions and layoffs. The positive selection identified in the firm implies that non-management employees with longer tenure are of higher average ability than more recently hired individuals. Above it is argued that this will lead to higher average performance of the tenured employees, and consequently to a higher probability of promotion. Since the tenure-effect on promotions is working through the performance variable, taking the employees performance into account would remove the tenure-effect, allowing only performance to have a significant effect on promotions. A similar argument goes for the layoff probability. The expected higher average performance of the high-tenured individuals will at first create a negative relation between layoffs and tenure. However, conditional on performance, tenure will become insignificant.

These hypotheses are tested empirically using logit models for the probability of being promoted and laid off. The results are presented in Figure 9. A first observation is that promotions and layoffs are very difficult to predict if information on performance is missing. In model 1, where the probability of a promotion is estimated unconditional of employee performance, the expected tenure-effect, is absent. Instead, there is a weak indication that skills are important for the promotion process, since individuals with a master’s or a Ph.D. degree have a marginally higher probability of being promoted than do unskilled workers. This result, however, is washed out, when conditioning on performance (model 2), indicating that education is important for the promotion process, but
only through its positive effect on the likelihood of getting bonuses. This leads to the conclusion that the firm only promotes workers who have shown persistent high-performance, and that the direct effect of tenure on promotions is too weak to be identified in the present firm.

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Note: Standard errors are clustered with respect to individuals. In the period studied individuals with a short theoretical education are not promoted. These regressions consider only transitions out of non-management.

Figure 9: Layoff and promotion regressions

The first layoff regression (model 3) in Figure 9 shows a pattern similar to the promotion-regression, namely, that layoffs are difficult to predict if information on performance is absent. In model 4, it is reestablished that information on bonus payments has a highly significant effect on the decision about who to lay off. Also, there is an indication that layoffs are rare for newly hired individuals, i.e., employees with tenure less than two years. For the remaining employees (tenure above two years), the tenure-effect is insignificant.

An additional point that arises from the results is that some employee subgroups (defined by education) are more likely to be laid off than others. This result seems to stay, even when performance is taken into account. This empirical result, however, may simply be an artifact of missing lay-off information. The indicator of layoffs observed in the data only reflects a lower bound on the real extent of layoffs (as discussed above). In particular, the empirical result observed will emerge if the firm is more likely to signal that an employment match is about to end, to some employee subgroups relative to others. In this particular case, it is explained if skilled workers (typically production workers) are more likely to get this information than white-collar workers. This can be due to increased sensitivity of information handled by more educated employees. Given the available data, we can only speculate about these matters.

In sum, the empirical evidence presented above provides evidence for the model’s conjectures.
First, using the description of the empirical contract and the multinomial logit regression, it is established that the firm is sorting, such that high-performing employees are more likely to be promoted, and, subsequently, are less likely, to be fired. Furthermore, these results show that the firm is using a selection scheme that is positive in both tenure and rank. Using the information on sorting and selection then, the model provides prediction about other key variables. The broader predictions related to bonus payments, earnings growth, promotions, and layoffs are all supported by the data.

6 Discussion

In the seminal work by Gibbons and Waldman [1999a,b], they argue that: "Any single (empirical) fact may be consistent with a variety of theories, so one way to choose among theories is by evaluating the extent to which each is consistent with a broad pattern of (empirical) evidence." This paper has attempted to do exactly that.

As to the initial research question of how the incentive-mix observed in firms can be seen as an optimal contract, this paper focuses on the job-assignment model. Within this context, it is argued that the firm’s sorting and selection concerns, and its interest in creating incentives for employees, provide the answer. This is a contribution in a theoretical sense, but according to the Gibbons and Waldman critique, the true test of the model lies in its ability to predict additional empirical findings. For this reason we conduct an empirical analysis, where evidence for sorting and selection is identified, and the model’s broader predictions are tested. In general, there is a close fit between the model’s conjectures and the empirical evidence.

However, in one respect, namely in the model’s ability to explain fixed-wage dynamics, the conjectures seem not to be supported by the data. This suggests that the job-assignment model should be extended by other building blocks in a larger integrative model, as suggested in Gibbons and Waldman (1999a,b). In the following, we discuss the empirical findings that an integrative model has to accommodate. Also, we explore possible theoretical explanations and provide suggestions for future research.

Figure 10 presents a set of Mincer wage equations. In contrast to the standard case, these regressions include information on the firm’s hierarchy. Thus, the results obtained reflect within-rank wage dynamics. Model 1 shows that the wage is increasing in the levels of education, tenure, and rank. Model 2 explores the effect of a bonus payment on current wages. The point-estimate shows that a bonus payment last period (which also can be interpreted as high performance) leads to significantly higher current wages. An extension of this analysis is conducted in model 3, where information of up to three years of lagged bonus payments is included. The remarkable result reveals that lagged bonus payments are highly significant. Furthermore, they have similar effects on current wages. Hence it is not the timing, but instead the event of bonus that seems to be important.

To investigate this issue further, model 4 estimates the effect of the last two years’ bonus payments on the wage, together with an interaction-effect, capturing the consequences for current wages of receiving bonuses in both years. The interaction-term in this regression is insignificant,
reflecting that bonuses are increasing wages every time they are observed. In other words, the bonus-effect is not deflated or magnified when the employee is observed to have a persistent high performance. These empirical observations are not easily explained by the job-assignment model, but a variety of other theoretical explanations provide possible explanations. Here, on-the-job human-capital acquisition, symmetric learning, and asymmetric learning with probabilistic outside offers are discussed.

The first potential explanation for the fixed-wage dynamics is on-the-job human-capital acquisition. Gibbons and Waldman (1999a,b) show how on-the-job human-capital acquisition, in conjunction with other building-block models (job assignment and learning) can be used to explain a large set of empirical evidence. The Gibbons and Waldman model distinguishes between the employees’ innate ability, which can be high or low, and effective ability, which is a function of the employees’ innate ability and labor-market experience. An assumption on symmetric information and steady changes in the employees’ effective ability caused by continuous growth in labor-market experience leads to fixed-wage dynamics. Thus, on-the-job human-capital acquisition implies a simple, upward-sloping fixed-wage scheme for all workers. On-the-job human-capital acquisition, however, cannot explain, without a stretch, the significant and positive coefficient on bonus payments, which we observe in our data.

Second, symmetric learning, first investigated by Farber and Gibbons [1996], offers an alternative explanation. Under symmetric learning, outside firms can be expected to condition offers on the very same signals as the currently employing firm. In the context of the theoretical model, and given the empirical evidence provided in Figure 10, the relevant quality signals are education, bonus payments, survival in the firm, and promotions. As potential outside employers observe these signals, the employee’s alternative option becomes a function of the employee’s perceived type. Raising $\bar{U}$, could, in principle, raise the fixed wage in order to secure that the participation constraint continues to be satisfied.

The third explanation is based on asymmetric learning, with probabilistic outside offers. If outside firms cannot observe bonus payments within the firm, the firm still might want to increase the fixed wage for those employees who are more likely to be of high ability. Let us suppose, for instance, that outside firms are uncertain, with respect to the worker’s quality, and give imprecise, probabilistic offers. Thus, sometimes, good employees leave the firm for alternative jobs. Yet, if the firm learns about the type of the worker, it might increase the wages of those employees who are likely to be of high ability. The reason to do this is that the firm can reduce the probability of high-quality employees leaving the firm. Thus, probabilistic outside offers can also lead to wage increases in perceived type, as conjectured above. The advantage of the probabilistic outside-offer explanation is that it does not necessarily require that the current firm and outside firms have the same information about employees.

---

24

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Note: Standard errors are clustered with respect to individuals in models 1 to 4. The lagged variables included in the regressions determine the number of observations used in the estimation.

Figure 10: Mincer wage equations
In sum, a variety of explanations are available to answer how signals create fixed-wage dynamics. These theories imply that our job-assignment model can be extended to capture wage dynamics. Yet, to step further, more research is needed on firm-level data in order to evaluate the relative merits of the above theories. At this stage, we can only say that wage dynamics can be made consistent with the model.

7 Conclusion

Firms are known to offer highly complex incentive contracts to their employees. Such contracts most often contain fixed wages, bonus payments, promotions, and layoffs. In this paper, we aim at understanding why firms prefer such an incentive mix. In order to do so, a theoretical model is built, and subsequently it is tested on personnel data. The key result is that firms that are concerned about the quality of the workforce have an interest in using the full incentive mix. In particular, these firms use firing, because it contributes to selection, besides its incentive role.

This finding is important for two reasons. First, it shows that regulating firing has profound implications for firm profitability. The reason is that quality-concerned firms might want to fire badly performing employees, even when the level of employment is constant, to improve the average quality of their workforce. Thus, labor-market regulations limiting firing might well put these quality concerned firms at a comparative disadvantage when competing on the international market. Second, this paper refocuses attention on firing in personnel economics by illustrating that firing has profound and unexpected consequences. For instance, it is shown theoretically, that positive selection on tenure within a given rank is a possibility. This finding, which is supported by the data, challenges previous research in the area.

In addition, this paper shows that a hierarchy of incentives might prevail. Firms with homogeneous employees, or without quality concern, would like to introduce incentives in the following order: promotions, bonuses, and, finally, fixed wages. Promotions are preferred over bonuses, because they use free, residual incentives, such as managerial rent. This rent can be exploited through promotions to elicit effort from the lower ranks. Fixed-wages, absent firing, do not provide incentives, yet they might be necessary to secure employee participation, if bonuses and promotions prove to be insufficient.

This paper also provides a useful theoretical innovation, as it uses the optimal steady-state contract to derive conjectures about the employee’s career dynamics within the firm. These predictions describe wage and earnings growth, promotion, and layoff probabilities, as well as the probability of receiving bonus payments for the individual employee. In the empirical analysis, these conjectures are found to be consistent with the empirical evidence. The success in testing a broad set of conjectures, besides the single prediction of the incentive mix allow, us to state that the paper accommodates the Gibbons and Waldman critique.

In conclusion, this paper casts a fresh new light on employee incentives, by investigating them in a joint empirical-theoretical framework. The results advance our understanding of the incentive role of firing in firms and its consequences for employee selection. Equally important, the paper paves the way for future research. In particular, including other building blocks besides job-assignment, it potentially contributes to an improved understanding of observed firm behavior.
8 Appendix

8.1 Proofs

8.1.1 Basic model

Proof of Lemma (1). Notice first that the profit is a linear function of the firing probability:

\[
(\theta + \delta) C - e + (\theta + \delta) \left[ b + \frac{gH}{H(\theta + \delta)} U_P \right] - (1 - \theta - \delta) \pi_F U_P - \bar{U} - (\theta + \delta) b - \left[ (1 - \theta - \delta) \pi_F + g + \frac{gM}{H} \right] K
\]

and that the bonus \((b)\) is canceling out of the equation. Then the first-order condition, in terms of the firing parameter, can be written as:

\[
-(1 - \theta - \delta) U_F - (1 - \theta - \delta) K < 0.
\]

Thus, firing is minimized in equilibrium. The result corresponds to our intuition, that the costs of motivating through firing increase in
- the cost of hiring and training \((K)\)
- the utility loss of firing \((U_F)\)
- the likelihood when firing has to be used \((1 - \theta - \delta)\).

Proof of Remark (1). The proof follows directly from the intuition provided prior to the remark. Slack means either zero-bonus and firing for promotion-slack (equation 5), or zero-bonus for bonus-slack (equation 3), or zero-wage for wage-slack (equation 4). Thus, no optimal incentive-mix can arise.

8.1.2 Job-assignment model

Proof of Remark (2). The proof is straightforward. If the profit derivative with respect to \(\pi_P\) is positive, then, naturally, the upper bound is reached. Furthermore, note that

\[
\frac{\partial b}{\partial \pi_P} = -U_P, \\
\frac{\partial w}{\partial \pi_P} = 0,
\]

and also that \(\frac{\partial \mu_F^*}{\partial \pi_P}\) and \(\mu_F^{H*}\) are independent of \(U_P\). Thus, increasing \(U_P\) sufficiently will guarantee that

\[
\frac{\partial \Pi}{\partial \pi_P} > 0.
\]

Proof of Lemma (2). Given a fixed-firing probability, the percentage of good workers employed by the firm can be determined. The measure of good employees promoted to managerial ranks is given as:

\[
\mu_F^*(\theta_G + \delta) \pi_P.
\]
Furthermore, the measure of good employees fired is
\[ \mu^*_F (1 - \theta_G - \delta) \pi_F, \]
and the measure of good employees exogenously retiring is
\[ \mu^*_F g. \]

The steady-state condition is that the composition of the workforce does not change any further. This can be captured as the measure of good employees leaving the non-management rank in any period equal to the measure of good employees entering the non-management rank. It is summarized in the following equation:

\[
\frac{\text{measure of good type, newly hired}}{\text{measure of all fired}} = \frac{\mu^*_F (1 - \theta_B - \delta) \pi_F}{\mu^*_F (1 - \theta_G - \delta) \pi_F} + \mu^*_F (1 - \theta_G - \delta) \pi_F + g
\]

The statement on \( \mu^*_F \) follows directly from here.

For management, the steady-state composition is given by the following logic. In the steady-state, only the equilibrium proportion of promoted workers matters, if \( F \) binds. All initial differences - if any - are deflated to zero by natural turnover \( g \). The volume of good-quality workers promoted is given by \( \mu^*_F (\theta_G + \delta) \pi_F \), and the volume of bad-quality workers promoted is \( (1 - \mu^*_F) (\theta_B + \delta) \pi_F \).

Also, if \( F \) does not bind, the slack is filled from the outside pool, with average quality \( \mu \). Hence, the proportion is given in the lemma.

**Proof of Lemma (3).** It is straightforward to create an example of an interior solution. Take, for example, the parameter choice used for Figure (2). The parameters used there are: \( \mu = .4, \theta_G = .5, \theta_B = .2, \delta = .2, \ C = 9, \ H = 25, \ K = 3, \ e = .85, \ g = 6\%, \ g' = 2\%, \ U_F = 1, \ U_P = 1, \) and \( \bar{U}_G = 2, \ M = 25 \). In equilibrium, the incentive-mix is: \( \pi_F = 3.25\%, \pi_P = .15\%, \ w = .9075, \) and \( b = 4.2185 \) (note: values are rounded).

For the simulation: Expressing profit as the function of the firing \( (\pi_F) \), and the promotion parameter \( (\pi_P) \) is straightforward, using the following easing notation:

\[ \mu^*_F = \mu \frac{(1 - \theta_B - \delta) \pi_F + g}{(1 - \theta_G - \delta) \pi_F + \mu (\theta_G - \theta_B) \pi_F + \pi_F + (\theta_G + \delta) \pi_P + g} \]

The expression is:

\[
\Pi(\pi_F, \pi_P) = \frac{\pi_F \mu^*_F (\theta_G + \delta) + \left( M \frac{\frac{M}{H \mu^*_F (\theta_G + \delta) + \frac{\mu}{(1 - \mu^*_F) (\theta_B + \delta)} + \pi_P U_F + \pi_P U_P} \right) \mu \frac{M}{H}}}{\pi_F (\delta + \mu^*_F (\theta_G - \theta_B) + \theta_B) + \left( (1 - \mu^*_F)(\theta_B + \delta) (C - \frac{\mu}{\delta} + \pi_F U_F + \pi_P U_P) \right) \mu^*_F (\theta_G + \delta)} + \left( (1 - \mu^*_F)(\theta_B + \delta) (C - \frac{\mu}{\delta} + \pi_F U_F + \pi_P U_P) \right) \mu^*_F (\theta_G + \delta)
\]

\[ - e + (\theta_G + \delta) \left( \frac{\mu}{\delta} - \pi_F U_F \right) - (1 - \theta_G - \delta) \pi_F U_F - \bar{U} \]

\[ - \mu^*_F (1 - \theta_G - \delta) \pi_F K \]

\[ - (1 - \mu^*_F)(1 - \theta_B - \delta) \pi_F K \]

\[ -(g + \frac{g_M}{H}) K \]

28
This two-variable equation is depicted in Figure (2). The F-constraints, however, must be separately checked in the simulation.

**Proof of Lemma (4).** For the first statement, consider the following (and remember that $F$ is binding):

$$
\mu_F^* < \mu_F^{M*} = \frac{\mu_F^*(\theta_G + \delta)}{\mu_F^*(\theta_G + \delta) + (1 - \mu_F^*)(\theta_B + \delta)}
$$

$$
\mu_F^*(\theta_G + \delta) + (1 - \mu_F^*)(\theta_B + \delta) < (\theta_G + \delta)
$$

$$
(1 - \mu_F^*)(\theta_B + \delta) < (1 - \mu_F^*)(\theta_G + \delta)
$$

For the second statement, consider the following:

$$
\Pr(\text{tenure} = j, \text{rank} = r | G) = k_{(j,r)} \left[ (\theta_G + \delta) \pi_F \right]^r \left[ 1 - (\theta_G + \delta) \pi_F - (1 - \theta_G - \delta) \pi_F \right]^j
$$

$$
= k_{(j,r)} \left[ (\theta_G + \delta) \pi_F \right]^r \left[ 1 - \pi_{S(G)} \right]^j,
$$

$$
\Pr(\text{tenure} = j, \text{rank} = r | B) = k_{(j,r)} \left[ (\theta_B + \delta) \pi_F \right]^r \left[ 1 - (\theta_B + \delta) \pi_F - (1 - \theta_B - \delta) \pi_F \right]^j
$$

$$
= k_{(j,r)} \left[ (\theta_B + \delta) \pi_F \right]^r \left[ 1 - \pi_{S(B)} \right]^j
$$

for $j \geq 0$, $0 \leq r \leq j$, where $r$ and $j$ are integers, and $k_{(j,r)}$ are coefficients, depending upon $j$ and $r$. $\pi_{S(G)}$ and $\pi_{S(B)}$ are the probabilities of not leaving a given rank for the good and bad workers, respectively. Recalling that the initial proportion of good types hired by the firm is $\mu$, then the probability of being of a good type, conditional on tenure and rank, becomes

$$
P_G = \frac{\mu k_{(j,r)} \left[ (\theta_G + \delta) \pi_F \right]^r \left[ 1 - \pi_{S(G)} \right]^j}{\mu k_{(j,r)} \left[ (\theta_G + \delta) \pi_F \right]^r \left[ 1 - \pi_{S(G)} \right]^j + (1 - \mu) k_{(j,r)} \left[ (\theta_B + \delta) \pi_F \right]^r \left[ 1 - \pi_{S(B)} \right]^j},
$$

and the probability of being a bad type, given tenure and rank, is

$$
P_B = \Pr(B|\text{tenure} = t, \text{rank} = r) = 1 - P_G,
$$

using the fact that good workers are more productive than bad workers, i.e., $\theta_G = \theta_B + \epsilon$ with $\epsilon > 0$, and the notation that $\pi = \pi_F = \pi_F + \gamma$, we can calculate the ratio of the proportion of good
workers, relative to the proportion of bad workers, in the firm at a given tenure and rank

\[ M_G = \frac{P_G}{P_B} \]

\[ = \frac{\mu k_{(j,r)} [(\theta_G + \delta) \pi_P] \gamma}{(1 - \mu) k_{(j,r)} [(\theta_B + \delta) \pi_P] \gamma} \left[ 1 - (\theta_G + \delta) \pi_P - (1 - \theta_G - \delta) \pi_F \right] \gamma^2 \]

\[ \left[ 1 - (\theta_B + \delta) \pi_P - (1 - \theta_B - \delta) \pi_F \right] \gamma^2 \]

\[ = \frac{\mu [(\theta_B + \epsilon + \delta) \pi] \gamma^2 [1 - (\theta_B + \epsilon + \delta) \pi - (1 - \theta_B - \epsilon - \delta) \gamma]}{(1 - \mu) [(\theta_B + \delta) \pi] \gamma^2 [(1 - \pi) + (1 - \theta_B - \delta) \gamma]^j} \]

\[ = \frac{\mu (\theta_B + \epsilon + \delta)}{(1 - \mu) (\theta_B + \delta)} \gamma^2 \left[ (1 - \pi) + (1 - \theta_B - \epsilon - \delta) \gamma \right]^j \]

\[ = \frac{\mu}{(1 - \mu)} (A)^j \cdot (B)^j. \]

When \( \gamma = 0 \Rightarrow \pi_P = \pi_F, \epsilon > 0 \)

\[ M_G = \frac{\mu}{(1 - \mu)} \left( \frac{\theta_B + \epsilon + \delta}{\theta_B + \delta} \right)^j \]

hence,

\[ \frac{dM_G}{d(r)} > 0, \frac{dM_G}{d(j)} = 0. \]

In the case where \( \gamma > 0 \Rightarrow \pi_P > \pi_F \) and \( \epsilon > 0 \) we have that \( A > 1, B < 1 \), hence,

\[ \frac{dM_G}{d(r)} > 0, \frac{dM_G}{d(j)} < 0 \]

and when \( \gamma < 0 \Rightarrow \pi_P < \pi_F \) and \( \epsilon > 0 \), we have that \( A > 1, B > 1 \), hence,\(^{29}\)

\[ \frac{dM_G}{d(r)} > 0, \frac{dM_G}{d(j)} > 0. \]

\section*{Proof of Corollary (1)}

Lem (4) has direct implications for the bonus payments, since

\[ \Pr(bonus) = P_G(\theta_G + \delta) + P_B(\theta_B + \delta) \]

\[ = P_G(\theta_G + \delta) + (1 - P_G)(\theta_B + \delta) \]

\[ = P_G(\theta_G + \delta) + (1 - P_G)(\theta_G - \epsilon + \delta) \]

\[ = \theta_G + \delta - \epsilon(1 - P_G). \]

Hence,

\[ \frac{d\Pr(bonus)}{d(j)} = \frac{dP_G}{d(j)} \]

\[ \frac{d\Pr(bonus)}{d(r)} = \epsilon \frac{dP_G}{d(r)} \]

\(^{29}\)In general, \( A > 0 \), for all feasible values of \( \gamma \), if \( \epsilon > 0 \).
Finally, using
\[
\frac{dM_G(x)}{dx} = \frac{d}{dx} \frac{P_G(x)}{1 - P_G(x)} > 0 \Rightarrow \frac{dP_G(x)}{dx} > 0,
\]
and
\[
\frac{dM_G(x)}{dx} = \frac{d}{dx} \frac{P_G(x)}{1 - P_G(x)} < 0 \Rightarrow \frac{dP_G(x)}{dx} < 0,
\]
the corollary follows. ■

**Proof of Corollary (2).** Follows directly from Corollary (1). ■

### 8.2 Managerial rent

The model assumes that managerial rent exists, yet it only handles it in a closed form. Here we provide some reasons for this closed-form representation. There are two major explanations, and both of them build on the same observation, namely that managers affect the work of many subordinates.

The first approach justifies rents by incentives. Calvo and Wellisz (1979) argue that rent is an increasing function of hierarchical rank. Their model is based on costly supervision, where shirking employees are punished by firing. This punishment, however, is only effective as long as there are rents with respect to the job. As managers affect the work of many subordinates, they are given more rents to ensure no shirking. Thus, the firm might be tempted to offer higher compensation for managers, even if the nature of the work is not different, and all the workers and managers are identical. In sum, a wage (and rent) ladder might prevail, even absent quality differences.

The second rationale, suggested here, stems from the firm’s desire to curb managerial turnover (more than the turnover of the non-management level). The intuition is simple, and again it rests on the observation that managers affect the output of many other employees. If a non-management employee leaves, it disrupts his own output. If a manager leaves, the leave disrupts the output of the manager and all his subordinates. Consequently, the firm would like to give stronger incentives for managers than for workers to stay. If outside offers are probabilistic, rents can be used to induce loyalty. Thus, in this setting, the manager’s compensation will include rents (and higher ones than that of the employees).

Finally, managerial rent has empirical support. It is generally understood that employees prefer to be promoted with the ongoing conditions. Thus, managerial work is more desirable, supporting the first incentive explanation. Also, voluntary managerial turnover is lower than voluntary employee turnover, which lends support to the second explanation. In our data set, for instance, lower-level managers and vice-presidents have a 9.80-percent and a 15.35-percent lower turnover, respectively, than do employees.

In conclusion, then, we are comfortable with the closed-form modeling of managerial rents. The available empirical and theoretical evidence seems to support its existence.

### 8.3 Action-set conditioning

Conditioning the action set on output, as it was proposed in the model, is without the loss of generality.

In the basic model, the assumed action setup is general. The fact that the action set was constrained on output realizations does not change the equilibrium. It is straightforward to check
that the firm would promote only high-performance employees, and only fire low-performance ones. Similarly, the firm would not pay bonuses to low-performers, even if the action set would allow for that.

Under employee heterogeneity, the firm still prefers to promote well-performing employees, and to lay off individuals with low performance. The reason is twofold. First, promoting well-performing employees and laying off badly performing ones is useful for incentive purposes. Second, selection considerations also strengthen the promotion and layoff policy. As managerial output is relatively more important than non-managerial output \((C < M)\), better-quality employees are more desirable for promotion. Thus, the firm prefers to promote high-performance individuals, as they are more likely to have high ability. Similarly, conditioning layoffs on low performance makes sure that the fired individual is relatively more likely to be of low ability. This improves the overall quality of the workforce, and hence has a positive impact on productivity. Again, it is straightforward to see that bonuses are only paid to well-performing agents, just like in the homogeneous case.

8.4 Learning for promotion and firing

The firm action setup is constraining under employee heterogeneity. The action sets force strict history independence on the firm’s selection. Most importantly, the firm conditions its promotion and firing decisions only on the current period. However, the firm learns about its employees over the course of their career. Consequently, it might want to condition its promotion and firing decision on a longer history of past achievements. In the following, learning for promotion and firing is formally introduced. In particular, it is shown that learning would not change the model’s qualitative conjectures.

The firm can determine the likelihood that an employee is of good quality based on Bayesian updating. Posterior probability of good quality is denoted by \(\nu(i,j)\), where \(i\) is the number of high outputs, and \(j\) is the number of low outputs observed prior to the promotion or firing decision. As for terminology, \(\nu(i,j)\) is also called posterior quality. Note that the exact order of high- and low-output is irrelevant for the posterior probability. The value of \(\nu(i,j)\) can be determined by straightforward Bayesian updating. Rearranging yields:

\[
\nu(i,j) = \frac{\mu}{\mu + (1 - \mu) \left( \frac{\theta_B}{\theta_G} \right)^i \left( \frac{1 - \theta_B}{1 - \theta_G} \right)^j}
\]

The firm under learning would prefer to choose the best employees to promote. Note, that as employees have the same expected life span at the firm, irrespective of tenure, tenure (nor age) does not enter into the firm’s consideration. Thus, the firm sets a promotion threshold \(\nu^{**}\), and promotes all employees above that. The threshold must be set such that the firm does not promote more employees than the number of vacancies available (straightforward modification of the F-constraint). Note that the firm might have to randomize promotions, if too many employees are of the same posterior quality. Given this constraint, the relationship between high and low outputs can be determined:

\[
i \geq \frac{\ln \theta_G - \ln \theta_B}{\ln \nu^{**} - \ln \mu + \ln(1 - \mu) - \ln(1 - \nu^{**})} + \frac{\ln(1 - \theta_B) - \ln(1 - \theta_G)}{\ln \theta_G - \ln \theta_B} j
\]

\[
i \geq \alpha(\nu^{**}) + \beta j
\]
Note further that $\alpha(\nu^{**}) > 0$, if the firm promotes better employees than those from the outside pool, formally if $\nu^{**} > \mu$. This seems to be the case, in most realistic scenarios.

Similarly, the firm could set the firing threshold $\nu^*$, such that it fires employees with lower posterior quality. Ties are resolved with randomization, as before. Finally, the relationship between $i$ and $j$ can be set similarly:

$$i \leq \frac{\ln \theta_G - \ln \theta_B}{\ln \nu^* - \ln \mu + \ln(1 - \mu) - \ln(1 - \nu^*)} + \frac{\ln(1 - \theta_B) - \ln(1 - \theta_G)}{\ln \theta_G - \ln \theta_B} j,$$

where $\alpha(\nu^{**}) < 0$, if the firm fires employees worse than those of the outside pool ($\nu^* < \mu$). This, again, is realistic.

Learning provides a more detailed picture on employee careers than the job-assignment model. For instance, under learning, fast-track might arise. Consecutive good performance in the first few periods might propel employees into management. While those missing this early opportunity and accumulating too many bad realizations ($j$), might not be promoted for a long spell of time. The reason is that the posterior quality of the employee reacts less to high output than early on.

The most important conclusion, however, from our perspective, is that learning does not change the model’s qualitative conjectures. As stated in Conjecture (1), firing and the observed incentive-mix still would not arise without quality concern. Firing is still a costlier incentive than bonuses and firings. Conjecture (2) would still be fundamentally valid. Under learning, better-than-average employees of the firm are promoted. Thus, selection on rank (conditional on tenure) stays positive. Selection-on-tenure (conditional on rank) would depend upon some measure of the firing and promotion probabilities. In the job-assignment model, these measures are given simply by the conditional probabilities ($\pi_F, \pi_P$). In the history-dependent learning model, they are the result of some integrals. However, higher promotion decreases workforce quality, whereas higher firing increases the quality of the workforce. Thus, the basic message of Conjecture (2) is unchanged. As the last four conjectures (conjecture 3 to 6) essentially follow from the first two, they are not changed under learning. In sum, the model’s qualitative results are unchanged by learning.

Introducing history-dependence, however, could strain the model’s assumptions. Two examples are emphasized here. First, the continuum of employees, an easing assumption above, might prove to be crucial for the firm to commit to the history-dependent contract. The optimal contract might prescribe countably many (infinite) realizations. Committing to them is trivial, with a continuum of employees. Yet, with a realistic, finite number of employees, serious commitment concerns might arise. Second, learning might just rely too much on the infinite life of employees. In the model, longer tenure (and thus higher age) does not mean lower expected service to the firm. In order to handle retirement the simplified exogenous turnover assumption should be revised.

In sum, history dependence is not modeled for three reasons. First, modeling history-dependence does not change the model’s qualitative conjectures. Second, introducing it might strain the model’s other assumptions, and pose more questions than it answers. Third, our data set does not allow us to investigate long-run consequences of history dependence. The complicated implications of learning, though theoretically compelling, cannot be examined with our data.
## 8.5 Additional regressions

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<td></td>
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<tr>
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</tr>
<tr>
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Log likelihood: -1545.22
Observations: 97,925

Note: Reference category is: “Stay within rank”. In the period studied individuals with a short theoretical education are not promoted.

Figure 11: Multinomial logit
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<td>0.537</td>
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<td></td>
<td>(0.156)</td>
<td>(0.173)</td>
</tr>
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<td>Demographic variables</td>
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<td>YES</td>
</tr>
<tr>
<td>Job category</td>
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<td>YES</td>
</tr>
<tr>
<td>Time dummies</td>
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<tr>
<td>Log likelihood</td>
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<td>-6392</td>
</tr>
<tr>
<td># observations</td>
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<td>11261</td>
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</table>

Note: Standard errors are clustered with respect to individuals in the cross sectional models.

Figure 12: Bonus regression
References


