Threat of Dismissal: Incentive or Sorting?

Illoong Kwon*
Department of Economics
University of Michigan
Ann Arbor, MI 48109
E-mail: ilkwon@umich.edu

July, 2002
(Very Preliminary)

Abstract

This paper provides both a theoretical and an empirical analysis of the 'threat of dismissal' as an incentive device. A simple repeated moral hazard model with a limited liability assumption shows that it is optimal for the principal to use both the threat of dismissal and a performance-based bonus contract as incentive devices. The optimal contract also shows that the average wage increases with firm size, and that the dismissal rate decreases with firm size. Furthermore, the paper provides an empirical method to distinguish an incentive explanation from a sorting explanation for the threat of dismissal.

Using detailed personnel records of a large company, this paper shows that even though the probability of dismissal decreases with tenure, the slope of this probability with respect to performance becomes steeper, which is consistent with using the 'threat of dismissal' as an incentive device.

1 Introduction

The threat of dismissal as well as a performance-based wage contract is an important incentive device. However, it is theoretically puzzling why a principal would use a threat of dismissal when she can use a performance-based wage contract. Most of the previous literature has analyzed the threat of dismissal assuming that a performance-based wage contract is not feasible (see Shapiro and Stiglitz (1984), Calvo

*I would like to thank Charlie Brown, Kai-Uwe Kuhn, and Gary Solon for helpful discussion and comments. I also thank Kyoung-soo Yoon for excellent research assistance. All remaining errors are mine.

(1985), Kuhn (1986), Sparks (1986), MacLeod and Malcomson (1989), and Mori (1998)). Empirically, few studies have rigorously investigated the use of a threat as an incentive device, even though this threat of dismissal is one of the most important building blocks of 'efficiency wage' model. While many studies have found a negative relationship between termination and performance (see Weisbach (1988), Jensen and Murphy (1990), Kaplan (1994), Denis and Denis (1995), Conyon (1998), and Chevalier and Ellison (1999)), one can also explain such a negative relationship with a sorting (or learning) model in which a principal dismisses an agent who is not competent enough to carry out the task based on the observed performances. To our knowledge, no previous study has attempted to distinguish an incentive explanation from a sorting explanation for the threat of dismissal.

This paper shows that in a repeated moral hazard model with limited liability, it is optimal for the principal to use both the threat of dismissal and a performance-based bonus contract as incentive devices. When an agent's reservation utility is zero, the dismissal provides a zero *continuation* payoff. The principal can also provide a zero continuation payoff by always offering zero wages regardless of the outcomes. However, if the principal always offers a zero wage, the agent will not work hard. Therefore, only the dismissal can provide a zero continuation payoff, the largest penalty assuming the limited liability, without violating future incentive constraints.

The interactions between the threat of dismissal and the bonus contract provide several interesting results. First, the model predicts that the average wage will increase with firm size. Suppose that the marginal cost of dismissal is increasing in the number of employees who are fired ($= Nq$, where N is the number of employees, and q is the probability of dismissal) because the principal needs to replace them with new employees and train them, for example. If N increases, the marginal cost of dismissal increases for a given q, so q will decrease. Then, to maintain the same level of incentives, the principal will increase the monetary incentives (or bonus). Therefore, as N increases, the average wage (or bonus) increases. This result may explain why there is a significant, but unexplained, firm size effect in wages (see Brown and Medoff (1989)). Second, as the agent becomes more risk-averse, the principal may optimally increase the bonus while decreasing the threat of dismissal. This result provides a potential explanation for why some empirical studies have found no (or positive) significant relationship between risk and incentives (see Prendergast (2000)).

Characterizing the optimal threat of dismissal also provides an empirical method to distinguish an incentive model from a sorting model. When the cost of firing increases with the agent's experience, the *slope* of the probability of dismissal as a function of performance becomes steeper as the agent's experience (or tenure) increases. On the other hand, in a sorting model, the slope gets flatter over time as the extra observation provides less information over time.

Using detailed personnel records of insurance claims processors in a large insurance company, the paper shows that the absolute value of the dismissal probability slope increases with the worker's tenure. This result is consistent with the incentive model of dismissal.

The paper is organized as follows. Section 2 provides a basic model and characterizes the optimal contract. Section 3 extends the basic model and derives a testable hypothesis against a sorting model. Section 4 provides an empirical analysis.

2 Basic Model

Consider a standard two-period repeated moral hazard model with two effort levels and two outcomes.[1] An agent can either work hard (a_H) or shirk (a_L). If an agent works hard, a good outcome (y_1) occurs with probability p_H, while a bad outcome (y_0) occurs with probability $1 - p_H$. If an agent shirks, y_1 occurs with probability p_L and y_0 occurs with probability $1-p_L$. ($p_H > p_L$) The agent's utility function is $U(w, a) = u(w) - g(a_i)$ where w is the wage, $u(0) = 0, u' > 0$ and $u'' < 0$. ($i = H, L$) For simplicity, denote $g(a_H)$ by H and normalize $g(a_L) = 0$. The principal is risk-neutral. The principal observes the outcome (y) but not the effort level (a). Assume that inducing a_H is always optimal.

An important deviation from a standard repeated moral hazard model is that we allow the principal to fire the agent at the end of each period depending on the outcome. Given the history of outcomes Y_t, denote the probability of dismissal at the end of period t by $q_t(Y_t)$.

Throughout the paper we assume that the principal needs to maintain a constant number, N, of employees. Therefore, if a principal dismisses an agent, she must hire a new one. The cost of hiring new employees is $\frac{\phi n^2}{2}$ where n is the number of new employees to be hired, that is, $n = Nq$. The hiring cost includes, among other things, searching and training costs. Note that the marginal cost of hiring increases with n. The expected cost of hiring per worker is $\frac{1}{N}(\frac{\phi}{2}N^2q^2) = \frac{\phi N}{2}q^2$.

The timing of the game is as follows: At the beginning of each period, an agent decides whether to work (a_H) or shirk (a_L). At the end of each period, the outcome is realized, and the payments and the dismissal decisions are made according to the contract. If the principal fires an agent, she hires a new one before the next period begins.

The model assumes the limited liability of the agent throughout the model. That is, w can not be negative. Also for simplicity, assume that the reservation utility is zero.[2]

[1] All the qualitative results hold in a more than two periods model. In a later section, we will also consider a continuous outcome case.

[2] It is enough if the reservation utility is low enough that the participation constraint is not binding under the limited liability assumption. One might wonder why the participation constraint is not binding if there are many other similar firms offering the same wage. If the wage is above the market-clearing level due to the limited liability constraint, there will be

2.1 One-Period Model

For a benchmark, consider one period model. The contract takes the following form:

$$\{(w_0^s, w_1^s), (w_0^d, w_1^d), (q_0, q_1)\}$$

When the outcome is y_i $(i = 0, 1)$, w_i^s is the wage payment if the agent stays, w_i^d is the wage payment if the agent is dismissed, and q_i is the probability of dismissal. It is often more convenient to consider a contract in terms of utils. Then, we can rewrite the contract as

$$\{(v_0^s, v_1^s), (v_0^d, v_1^d), (q_0, q_1)\}$$

where $v_i^j = u(w_i^j)$. $(i = 0, 1,\ j = s, d)$ Define $h(.) = u^{-1}$. Then, $w_i^j = h(v_i^j)$. $(i = 0, 1,\ j = s, d)$

The principal's optimization is the following

$$\min_{\substack{v_0^s \geq 0, v_0^d \geq 0, v_1^s \geq 0, v_1^d \geq 0 \\ 0 \leq q_0 \leq 1, 0 \leq q_1 \leq 1}} (1 - p_H)\left[(1 - q_0)h(v_0^s) + q_0 h(v_0^d)\right] + p_H[(1 - q_1)h(v_1^s) + q_1 h(v_1^d)] \tag{1}$$

subject to

$$(1 - p_H)\left[(1 - q_0)v_0^s + q_0 v_0^d\right] + p_H[(1 - q_1)v_1^s + q_1 v_1^d] - H \geq 0 \tag{2}$$

$$\begin{aligned} & (1 - p_H)\left[(1 - q_0)v_0^s + q_0 v_0^d\right] + p_H[(1 - q_1)v_1^s + q_1 v_1^d] - H \\ \geq\ & (1 - p_L)\left[(1 - q_0)v_0^s + q_0 v_0^d\right] + p_L[(1 - q_1)v_1^s + q_1 v_1^d] \end{aligned} \tag{3}$$

The first constraint is a participation constraint and the second one is an incentive constraint. There is no cost of hiring new employees because this is a one-period model.

Proposition 1 *(i)* $v_0^s = v_0^d = 0$ *and* $v_1^s = v_1^d = \frac{H}{p_H - p_L}$.
(ii) Any $0 \leq q_0 \leq 1, 0 \leq q_1 \leq 1$ *are optimal.*
(iii) The participation constraint is not binding.

Proof See appendix.

Proposition 1 (i) shows that the payments do not depend on whether an agent is dismissed. Therefore, a severance pay or penalty is not optimal[3]. Because the agent only cares about his expected utility

involuntary unemployment. Therefore, the reservation utility (=outside option) should include the search costs incurred during the unemployment period. Then, the partcipation constraint will not be binding.

[3] A severance pay or a severance penalty may be used for insurance purposes when the matching quality between a principal and an agent is uncertain.

$(1-q_0)v_0^s + q_0 v_0^d$ or $(1-q_1)v_1^s + q_1 v_1^d$, there is no need for the principal to provide additional uncertainty of income to a risk-averse agent.

The second part of the proposition implies that the threat of dismissal does not matter, which immediately follows from (i). More intuitively, the worst payment that a principal can impose is a zero utility payment. Because the dismissal cannot provide a larger penalty, there is no particular reason to use the threat.

Since the principal cannot use a large penalty, the principal must offer large rewards. Therefore, the participation constraint is not binding with a limited-liability constraint. As the next section shows, this result plays an important role in a repeated game.

2.2 Two-Period Model

Now consider a two-period model. For simplicity, we assume that the principal and the agent cannot commit to a long-term contract.[4] Then, before the second period, if the agent stays, the principal and the agent signs a new contract for period 2.

The second period contract will be exactly the same as the one-period contract in the previous section. Let us consider the first period contract. Like in a one-period model, the payments will not depend on whether an agent is dismissed. Therefore, denote the first period contract as

$$\{(v_0, v_1), (q_0, q_1)\}$$

where v_i is the utility payment when the first period outcome is y_i. $(i = 0, 1)$

Denote the expected utility of the agent under the one-period optimal contract by $V_1^*(=\frac{p_L H}{p_H - p_L}) > 0$. Also denote the principal's expected cost under the one-period optimal contract by $C_1^*(= p_1 h(\frac{H}{p_1 - p_0}))$.

The principal's optimization problem is:

$$\min_{\substack{v_0 \geq 0, v_1 \geq 0 \\ 0 \leq q_0 \leq 1, 0 \leq q_1 \leq 1}} (1-p_H)\left[h(v_0) + (1-q_0)C_1^* + q_0 C_1^* + \frac{\phi N}{2}{q_0}^2\right] + p_H\left[h(v_1) + (1-q_1)C_1^* + q_1 C_1^* + \frac{\phi N}{2}{q_1}^2\right]$$

subject to

$$(1-p_H)(v_0 + (1-q_0)V_1^* + q_0 0) + p_H(v_1 + (1-q_1)V_1^* + q_1 0) - H \geq 0 \tag{4}$$

$$\begin{aligned} & (1-p_H)(v_0 + (1-q_0)V_1^* + q_0 0) + p_H(v_1 + (1-q_1)V_1^* + q_1 0) - H \\ \geq \; & (1-p_L)(v_0 + (1-q_0)V_1^* + q_0 0) + p_L(v_1 + (1-q_1)V_1^* + q_1 0) \end{aligned} \tag{5}$$

[4] It is easy to verify that the main results do not change in either a full-commitment or a renegotiation-proof case.

Note that due to the short-term contracting, the second period expected cost for the principal (C_1^*) remains the same. Furthermore, because there is a cost of hiring ($= \frac{\phi N}{2} q_i^2$), firing an agent does not reduce the costs of the principal directly. However, as Proposition 2 shows, the threat of dismissal can reduce the principal's costs through the incentive constraint.

Proposition 2 *(i)* $v_0^* = 0$ *and* $v_1^* = \frac{H}{p_H - p_L} - q_0^* V_1^* > 0$
(ii) $q_0^* > 0$ *and* $q_1^* = 0$ *where* q_0^* *solves, assuming interior solution,*

$$(1 - p_H)\phi N q_0 - p_H h'(\frac{H}{p_H - p_L} - q_0 V_1^*) V_1^* = 0 \tag{6}$$

Proof See appendix.

Since $q_0^* > 1$, it is optimal for the principal to use the threat of dismissal. Intuitively, the dismissal gives zero second-period utility to the agent. The principal can also provide zero second-period expected utility by offering zero wages in the second period regardless of the outcome. But in such a case, the incentive constraint will be violated and th agent will not work. Therefore, assuming the limited liability, the dismissal can provide a stiffer penalty than the wage without violating the incentive constraint. In a repeated moral hazard model with limited liability, it is optimal for the principal to use both a bonus($= v_1^* > 0$) and the threat of dismissal ($= q_0^* > 0$) as incentive devices.

Note that the first period bonus (v_1^*) is less than the second period bonus ($= \frac{H}{p_H - p_L}$). In the optimal long-term contract of a finitely repeated moral hazard model, it is easy to show that the bonus is increasing in tenure due to a utility-smoothing effect. However, in the absence of a long-term contract, the bonus does not change with tenure if the principal does not use the threat of dismissal. Therefore, the model predicts that the bonus will increase with tenure even in the absence of a long-term contract as long as the principal uses the threat of dismissal. Also note that the average wage is increasing in tenure even though the worker's average productivity does not change. This provides a potential explanation on the often-observed tenure premium.

Example 1 Consider a constant relative-risk aversion utility function $U(w) = 2w^{\frac{1}{2}}$ (that is, $h(u) = \frac{1}{4}u^2$), $p_H = 0.5$, $p_L = 0.25$, $H = 5$, and $\phi N = 50$. Without using the threat of dismissal, the two-period optimal contract is a repetition of the one period optimal contract, under the short-term contracting. The expected cost of the principal is $2[(1 - 0.5)0 + 0.5h(\frac{5}{0.5 - 0.25})] = 100$. Now suppose that the principal uses the threat of dismissal. From (6), $q_0^* = 0.8$ and $v_1^* = 16$. The expected cost of the principal becomes $(1 - 0.5)[0 + 0.5h(\frac{5}{0.5 - 0.25}) + \frac{50}{2}(0.8)^2] + (0.5)[h(16) + 0.5h(\frac{5}{0.5 - 0.25}) + 0] = 90$.

Since v_1^* is decreasing in q_0^*, one can establish the following proposition:

Proposition 3 *(i) A bonus and the threat of dismissal are substitutes as the agent's risk-aversion increases.*

(ii)The threat of dismissal is decreasing in ϕ and N, but the bonus is increasing in ϕ and N.

Proof See appendix.

Note that, as the agent becomes more risk-averse, if the principal lessens the threat of dismissal, then she will use a larger bonus (or vice versa). This result provides a potential explanation for why some empirical studies have found an insignificant or positive correlation between the agent's risk-aversion and the monetary incentives, even though the standard moral hazard model predicts a negative correlation. (see Prendergast (2000))

Also note that the bonus is increasing in N. Therefore, the average wage as well as the bonus in a larger firm will be higher than that in a smaller one. As N increases, the marginal cost of dismissal increases for a given q, so q will decrease. Then, to maintain the same level of incentives, the principal will increase the monetary incentives (or bonus). Therefore, as N increases, the average wage (or bonus) increases. While many empirical studies find a positive correlation between firm size and wages, a significant portion of the correlation remains unexplained. (see Brown and Medoff (1989)) Our proposition provides an alternative explanation for why a larger firm may pay more than a smaller firm.[5]

Example 2 (Continued from Example 1) Now suppose that $h(u) = \frac{1}{9}u^3$. That is, compared with example 1, the coefficient of relative risk-aversion has increased to $\frac{2}{3}$ from $\frac{1}{2}$. Then, from (*), $q_0^* = 1$ and $v_1^* = 15$. Therefore, as the agent gets more risk-averse, the threat of dismissal has increased, but the bonus has decreased. However, consider the same example except $H = 0.5$ and $\phi N = 1$. Then, $q_0^* = 0.51$ and $v_1^* = 1.75$ with $h(u) = \frac{1}{4}u^2$, but $q_0^* = 0.44$ and $v_1^* = 1.78$ with $h(u) = \frac{1}{9}u^3$. In this case, as the agent becomes more risk-averse, the threat of dismissal decreases and the bonus increases.

3 Dismissal: Incentive or Sorting?

So far we have studied an incentive problem with homogenous agents. However, when agents are heterogenous, an agent can be fired upon bad performance even when there is no incentive problem. For example, when an agent's productivity is unknown to the principal, the principal will update her expectation of the agent's productivity based on the observed performance. If performance is bad enough that the updated belief about the agent's productivity is below a certain threshold level, the agent can be dismissed. Therefore,the negative correlation between performance and dismissal, a static property, does not distinguish an incentive model from a sorting (or learning) model.

[5] See Zabojnik (2001) for an alternative approach.

In this section, we show that there is a dynamic aspect of the threat of dismissal that can distinguish an incentive explanation from a sorting explanation.

3.1 Incentive Model

To compare with a sorting model, first consider an extension of the basic model to a continuous outcome, infinite-horizon case. Now assume that the p.d.f. of an agent's performance for a given effort level a_j is $f_j(y)$. $(j = L, H)$. $f_H(y)$ first-order stochastically dominates $f_L(y)$. Also $\frac{f_H(y)}{f_L(y)}$ is increasing in y. (monotone likelihood assumption) Now suppose that there are an infinite number of periods. Like before, for simplicity, we will continue to assume that a long-term contract is not feasible. Also assume that the discount factor is one.

Denote the payments to an agent (in utils) for a performance y by $v(y)$. Consider an optimization problem for an agent with tenure t. Define V as the continuation payoff of the agent if he is not dismissed. Like the basic model, V is positive under the limited liability constraint. Denote the continuation cost of the principal $C_0(t)$ if she fires the agent and $C_1(t)$.if she does not.

Then for an agent with tenure t, the principal's optimization is as follows:

$$\min_{v(y)\geq 0, 0\leq q(y)\leq 1} \int [h(v(y)) + q(y)C_0(t) + (1-q(y))C_1(t) + \frac{\phi N}{2} q^2(t)] f_H(y)dy$$

subject to

$$\int [v(y) + (1-q(y))V] f_H(y)dy - H \geq 0 \quad (7)$$

$$\int [v(y) + (1-q(y))V] f_H(y)dy - H \geq \int [v(y) + (1-q(y))V] f_L(y)dy \quad (8)$$

From the FOCs,

$$v^*(y) = \max\{h'^{-1}(\lambda(1 - \frac{f_L(y)}{f_H(y)})), 0\} \quad (9)$$

$$q^*(y) = -\frac{1}{\phi N}[\lambda V(1 - \frac{f_L(y)}{f_H(y)}) + \Delta_t] \text{ if } 0 \leq q(y) \leq 1 \quad (10)$$

where $\Delta_t \equiv C_0(t) - C_1(t)$.

Proposition 4 *(i)* $\frac{\partial q^*(y)}{\partial y} < 0$

(ii) If Δ_t *increases in* t*, then* $\left|\frac{\partial q^*(y)}{\partial y}\right|$ *also increases in* t*.*

Proof See appendix

Intuitively, as Δ_t increases with tenure, the level of q decreases because it becomes more costly to fire an agent. However, as the level of q decreases (that is, as the level of threat of dismissal decreases), there will be less incentives for the agent. To compensate for this reduction in incentives, the principal will increase the marginal threat of dismissal as well as the marginal wage. See Figure 1 for an example.

[Figure 1]

Δ_t may increase with tenure for various reasons. For instance, there are more political and social costs of firing an veteran employee. Also, if a firm-specific human capital accumulates over time, the dismissal of a more experienced employee becomes more costly. This interpretation requires caution, however, since f_H and f_L will change as well in learning-by-doing model.

3.2 Sorting Model

Now consider a multi-period sorting (or learning) model in which the principal observes the agent's performance y_t every period. Suppose that an agent' performance in period t (y_t) is

$$y_t = \theta_t + K_t + \epsilon_t$$

where θ_t is the agent's productivity (or his innate ability), K_t is the agent's acquired human capital, and ϵ_t is the random noise. Only y_t is observable, and neither the principal nor the agent observes θ_t or ϵ_t. The prior distribution of θ_1 follows a normal distribution, $N(0, \sigma_1^2)$. ϵ_t's are independently and identically distributed according to a normal distribution $N(0, \sigma_\epsilon^2)$. K_t evolves deterministically through learning-by-doing. That is, $K_t = K_{t-1} + d_{t-1}$, where $d_{t-1} \geq 0$ is the amount of learning-by-doing in period $t-1$. For simplicity, assume that $K_1 = 0$.

Denote the posterior distribution of y_t at the beginning of period t by

$$y_t \sim N(m_t, \sigma_t^2)$$

At the beginning of each period, the principal decides whether to renew the contract or terminate the contract and hire a new agent. For simplicity, we assume that the principal is *myopic*: She maximizes the current period payoff in each period.

Suppose that the agent's performance in period t is y. As before, denote the probability of dismissal by $q_t(y)$. Then, the principal's optimization problem at the beginning of period $t+1$ is as follows:

$$\max_{0 \leq q_t(y) \leq 1} q_t(y)0 + (1 - q_t(y)) \left(\frac{\sigma_\epsilon^2 m_t + \sigma_t^2 y}{\sigma_\epsilon^2 + \sigma_t^2} + d_t \right) - \frac{\phi N}{2} q_t(y)^2$$

The FOC for $q_t(y)$ is as follows:

$$-\frac{\sigma_\epsilon^2 m_t + \sigma_t^2 y}{\sigma_\epsilon^2 + \sigma_t^2} - d_t - \phi N q_t(y) - v_0(y) + v_1(y) = 0$$

where $v_0(y)$ and $v_1(y)$ are the Lagrangian multipliers for the constraints $q_t \geq 0$ and $q_t \leq 1$ respectively. Therefore, the optimal contract renewal (or dismissal) policy is:

$$q_t^*(y; m_t) = \begin{cases} 1 & \text{if } y < -\frac{\sigma_\epsilon^2 m_t + \phi N(\sigma_\epsilon^2+\sigma_t^2) + d_t(\sigma_\epsilon^2+\sigma_t^2)}{\sigma_t^2} \\ -\frac{1}{\phi N}\left(\frac{\sigma_\epsilon^2 m_t + \sigma_t^2 y}{\sigma_\epsilon^2+\sigma_t^2} + d_t\right) & \text{if } -\frac{\sigma_\epsilon^2 m_t + \phi N(\sigma_\epsilon^2+\sigma_t^2) + d_t(\sigma_\epsilon^2+\sigma_t^2)}{\sigma_t^2} \leq y \leq -\frac{\sigma_\epsilon^2 m_t + d_t(\sigma_\epsilon^2+\sigma_t^2)}{\sigma_t^2} \\ 0 & \text{if } y > -\frac{\sigma_\epsilon^2 m_t + d_t(\sigma_\epsilon^2+\sigma_t^2)}{\sigma_t^2} \end{cases}$$

Proposition 5 *(i) For* $0 < q_t^*(y; m_t) < 1$, $\frac{\partial q_t^*(y)}{\partial y} = -\frac{1}{\phi N}\frac{\sigma_t^2}{\sigma_\epsilon^2+\sigma_t^2} < 0$, *and* $\left|\frac{\partial q_t^*(y)}{\partial y}\right|$ *decreases in t..*

(ii) Keeping m_t *constant,* $q_t^*(y)$ *decreases in t.*

Proof See appendix.

Note that regardless of the history of outcomes, $\left|\frac{\partial q_t^*(y)}{\partial y}\right|$ decreases in time, because the marginal informational value of additional observation decreases with the number of observations. This result does not change even with learning-by-doing (that is, $d_t > 0$), because it does not change how σ_t^2 evolves. Furthermore, it is likely that the absolute level of q_t will decrease, because, on average, m_t is likely to increase over time for those who have not been dismissed. The presence of learning-by-doing will also make the dismissal probability decrease.

Therefore, in a sorting model, the marginal threat of dismissal ($= \left|\frac{\partial q_t^*(y)}{\partial y}\right|$) will decrease with time. Also the absolute level of the threat ($= q_t(y)$) is also likely to decrease with time. See Figure 2 for an example.

[Figure 2 here]

Proposition 4 and 5 suggests that when the (opportunity) cost of dismissal increases in tenure, there is a way to distinguish an incentive explanation from an sorting explanation for a dismissal. Even though the dismissal probability decreases in performance in both models, the slope of dismissal probability gets steeper in an incentive model, but flatter in a sorting model.

4 Empirical Analysis

In this section, we investigate whether the threat of dismissal is used as an incentive device using a unique dataset. The dataset is ideal for our purpose because it includes detailed information on the performance, compensation, and termination of employees.

4.1 Data

The data are from the personnel records of insurance claim processors in a large insurance company in US. The original dataset includes 5,888 processors over two and a half year period (01/01/93-06/30/95). Of this group, I restrict the focus to 3,231 full-time employees working only on indemnity claims.[6] The data contain detailed information on employee performance, compensation, and termination.

Table 1 provides the summary statistics. About 90% of the employees are female, and 56% of them are married. The average age is 31 years old. Most of employees have high school diploma, and about 30% of them have a college education or higher. On the whole, these employees can be characterized as female, white-collar, non-managerial, service industry, full-time workers. Even though this group of employees is growing fast in the economy, few studies have been done on them.

There are four major levels of job hierarchy. All the employees start from the lowest level and are promoted to higher levels. See Kwon (1999) for details. Compensation includes salary, bonus, and overtime payment. The average 6-month compensation is about $11,000.

Performance is measured by the weighted number of claims processed a day. The company has developed the weighting system to reflect different types of claims. This measure provides not only an objective but also consistent performance measure across different job-levels. This is important because we need to compare the estimated coefficients of the regressions cross different tenure and job-levels. Baker, Gibbs, and Holmstrom (1994) measure performance with a subjective rating from the manager. Since such a measure has no consistent unit across different job levels, it is meaningless to compare the size of coefficients cross different job levels.

Turnover rates are relatively high. About 30% of the employees in the sample quit during the two and a half year sample period. The median tenure is about 3 years (=79/26). However, this sample median underestimates the true median because the tenure variable is right-censored. For the workers who still remain at the end of the sample period, we do not observe their maximum tenure. Later, we will conduct a duration estimation to control for this censored variable.

Table 2 provides detailed information on terminations. About 65% of the terminations are voluntary, and the rest 35% of them are involuntary. Many previous studies do not distinguish between voluntary and involuntary termination (e.g. Chevalier and Ellison (1999)). Even though some studies have attempted to distinguish between them (e.g. Conyon (1998)), there are always some doubts on whether the voluntary termination is induced by the employer's intentional deterioration of working conditions (for example, lower wage, no promotion, etc.). In our dataset, the detailed information on the reason for termination can

[6] The rest of the processors work on HMO claims. From a workplace perspective, the nature of HMO claims processed at this company appears to be sufficiently different from that of indemnity claims. Less than 0.5% of processors work on both indemnity and HMO claims. These processors are excluded.

minimize such doubt. For example, the terminations due to spouse relocation, health, or family obligation are likely to be truly voluntary. Most of the involuntary terminations are due to performance.

4.2 Duration Estimation

We first estimate the duration model to investigate the effect of individual characteristics on the duration. Table 3 shows the results of the Weibull duration model estimations. For all kind of terminations, the hazard rate decreases (or the duration increases) with age, gender (=1 if female, =0 male), and marital (=1 if married, =0 if single) status, while the hazard rate increases with education. The median of the predicted median duration is 7.7 years (=201/26), which is much larger than the sample median in Table 1.

Separate estimations of voluntary and involuntary termination show one interesting difference between the two. With voluntary terminations, education increases the hazard rate (or decreases the duration), while with involuntary terminations, education decreases the hazard rate. That is, better educated workers are more likely to quit voluntarily, while less likely to quit involuntarily. We also looked at the several specific types of voluntary terminations that are likely to be the disguised involuntary terminations, such as 'more money', 'entering new field', and 'advancement opportunity'. For all these types, education has positive effect on the hazard rate. Therefore, it appears that distinguishing between voluntary and involuntary terminations in this dataset is meaningful.

In all of the regressions, the estimated $1/p$ is larger than 1, which implies that the hazard rate decreases with tenure.

To estimate the effect of performance on the hazard rate, we would like to estimate a duration model with the performance variable, totalw, and analyze how the relationship changes over time. However, because the performance variable changes continuously over time, there is no practical way of estimating the duration model. In Table 4, instead, we estimate duration models with the individual sample mean of performance. We also included the individual mean of wages. The median of the predicted median duration is 4.19 years after controlling the average performance and the average wage.

Not surprisingly ,the mean performance (totalw) decreases the hazard rate of involuntary termination. It turns out that the mean performance also decreases the hazard rate of voluntary termination, especially 'advancement opportunity' or 'entering new field'. That is, such voluntary terminations are not induced by the fact that they are too good for the job.

After controlling average performance and wage, $1/p$ is less than 1, which implies that the hazard rate increases with tenure.

To analyze how the slope of the dismissal probability (or hazard rate) changes over time, we will use a probit model in next section.

4.3 Incentive or Sorting?

Our theoretical model predicts that when the dismissal cost for the principal is increasing in tenure, the absolute value of the dismissal probability slope increases under an incentive model, but decreases under a sorting model.

Before we look at the slope of the dismissal probability, we show that there is significant learning on the job during the first 5 to 7 years of tenure. Figure 3 shows a clear pattern of increasing productivity over tenure. However, this pattern could be due to the fact that the remaining employees are more productive. Table 5 shows that the increasing pattern is robust even after controlling for individual effects. Also confirming the results from duration estimation, the performance of those who quit either voluntarily or involuntarily is lower than the average. In particular, the workers who are terminated involuntarily have significantly lower productivity that those who are terminated voluntarily. This suggests that 'sorting' is one important reason for involuntary termination.

It is interesting to note that education has no significant effect on the productivity, because education has significant effect on both the wages and the threat of dismissal.

Table 6 shows the results from probit estimation. First, the interaction term between tenure and totalw has a significant and negative coefficient for involuntary termination, which is consistent with the incentive model. Although for overall voluntary terminations the interaction term has also negative coefficient, this term is not significant for specific voluntary terminations like 'advancement opportunity' or for 'more money'. Second, tenure has positive effect on involuntary terminations. Recall that the theory predicts that the tenure effect is ambiguous for an incentive model, while negative for a sorting model. Therefore, this result is more consistent with an incentive model. Tenure has negative, but insignificant effect on voluntary terminations.

Similar to the duration model estimation, education has positive effect for voluntary termination, but negative effect for involuntary termination.

The results in Table 6 could be driven by the heterogeneity of workers. The negative coefficients of the interaction terms in Table 6 could also be generated if the interaction term is acting as $(\text{tenure})^2$ or $(\text{totalw})^2$. Thus, we control the individual effect with a random effect probit estimation in Table 7. We also include $(\text{tenure})^2$.[7] Again, the interaction term has a significant and negative sign for involuntary termination, and there are no other qualitative changes from Table 6.

The absolute value of the dismissal probability slope could increase in a 'sorting' model if the variance of the noise (σ_ϵ^2) decreases over tenure. To check for this possibility, we compute the variance of an individual

[7] We also included $(\text{totalw})^2$ and/or job hierarchy dummies, but they changed none of the qualitative results. Furthermore, totalw^2 was not significant.

two-week average performance over a 6 month time period and regress it on tenure. Table 8 shows that the variance is increasing in tenure. Therefore, under a 'sorting' model, the absolute value of the slope should decrease even faster.

Our theory also predicts that the slope of the wage function should increase with tenure. Table 8 shows that this is indeed the case. However, as there are many alternative explanations for the increasing slope (e.g. career concern model, the finitely repeated moral hazard model, etc.), this evidence is not as strong as that from the probit estimation.

The incentive explanation for the threat of dismissal is consistent with the various aspects of the data. On the other hand, it also appears that the sorting is an important reason for involuntary termination. A future research can try to measure the relative importance of 'incentive' and 'sorting' effect in the threat of dismissal. Such research is likely to be a 'structural' one.

References

[1] Baker, G., M. Gibbs and B. Holmstrom, 1994a, "The Internal Economics of The Firm: Evidence From Personnel Data," *Quarterly Journal of Economics*, 881-919

[2] ________________, 1994b, "The Wage Policy of A Firm," *Quarterly Journal of Economics*, 921-955

[3] Calvo, G.A., 1985, "The Inefficiency of Unemployment: The Supervision Perspective," Quarterly Journal of Economics, 100, 379-387

[4] Chevalier, Judith and Glenn Ellison, 1999, "Career Concerns of Mutual Fund Managers," Quarterly Journal of Economics, 389-432

[5] Conyon, Martin J., 1998, "Directors' Pay and Turnover: An Application to A Sample of Large UK Firms," Oxford Bulletin of Economics and Statistics, 60, 4, 485-507

[6] Denis, D. J. and D. K. Denis, 1995, "Performance Changes Following Top Management Dismissal," Journal of Finance, 50, 1029-1057

[7] Jensen, M.C. and K.J. Murphy, 1990, "Performance Pay and Top Management Incentives," Journal of Political Economy, 98, 225-64

[8] Kaplan, S., 1994, "Top executive rewards and firm performance: A comparison of Japan and the United States," Journal of Political Economy, 102, 510-546

[9] Kuhn, P., 1986, "Wages, Effort, and Incentive Compatibility in Life-Cycle Employment Contracts," Journal of Labor Economics, 4, 28-49

[10] Kwon, I., 1999, "Wages, Incentives, and Promotions: Theory and Evidence," mimeo

[11] Levin, J., 2000, "Relational Incentive Contracts," mimeo

[12] MacLeod, W.B., 2001, "On Optimal Contracting with Subjective Evaluation," mimeo

[13] MacLeod, W.B. and J.M. Malcomson, 1989, "Implicit Contracts, Incentive Compatibility, and Involuntary Unemployment," Econometrica, 57, 447-480

[14] Mori, P.A., 1998, "Task Shifts vs. Termination as Devices for Eliciting Optimal Effort Supply," Journal of Economics and Management, 7, 33-65

[15] Prendergast, C., 2000, "What Trade-Off of Risk and Incentives?," American Economic Review, 90, 421-25

[16] Shapiro, C. and J. Stiglitz, 1984, "Worker Unemployment as a Worker Discipline Device," American Economic Review, 74, 433-444

[17] Sparks, R., 1986, "A Model of Involuntary Unemployment and Wage Rigidity: Worker Incentives and the Threat of Dismissal," Journal of Labor Economics, 4, 560-581

[18] Weisbach, M., 1988, "Outside directors and CEO turnover," Journal of Financial Economics, 20, 431-460

Appendix

Proof of Proposition 1 (i) Suppose that the participation constraint (2) is not binding. Consider the FOCs for v_0^s and v_0^d without the limited liability constraints. Since

$$\frac{\partial L}{\partial v_0^s} = (1-q_0)[(1-p_H)h'(v_0^s)+\lambda(p_H-p_L)] \geq 0 \quad \text{(A.1)}$$

$$\frac{\partial L}{\partial v_0^d} = q_0[(1-p_H)h'(v_d^d)+\lambda(p_H-p_L)] \geq 0 \quad \text{(A.2)}$$

, where λ is a Lagrange multiplier for (3), $v_0^s = v_0^d = 0$ is optimal. Also, it is easy to observe that $\frac{\partial L}{\partial v_1^s} = \frac{\partial L}{\partial v_1^d}$. Then, $v_1^s = v_1^d$. From the binding incentive constraint (3), $v_1^s = v_1^d = \frac{H}{p_H - p_L}$.

(ii) Substituting the results of (i) into the optimization problem shows that both q_0 and q_1 disappear from the optimization problem. Therefore, the size of q_0 and q_1 does not matter.

(iii) Since $v_1^s = v_1^d = \frac{H}{p_H - p_L} > 0$, from the incentive constraint (3), the participation constraint is not binding.■

Proof of Proposition 2 From the incentive constraint, the participation constraint is not binding since all the terms in the right-hand side of the incentive constraint are non-negative. Consider the FOCs for v_0 and q_1 without the limited liability constraints and without the constraint of $0 \leq q_1 \leq 1$. Since

$$\frac{\partial L}{\partial v_0} = (1-p_H)h'(v_0)+\lambda(p_H-p_L) > 0 \quad \text{(A.3)}$$

$$\frac{\partial L}{\partial q_1} = \phi N q_1 + \lambda(p_H-p_L)V > 0 \quad \text{(A.4)}$$

, where λ is a Lagrange multiplier for (5), $v_0 = 0$ and $q_1 = 0$ is optimal. Then, from the binding incentive constraint (5),

$$v_1 = \frac{H}{p_H - p_L} - q_0 V_1^* \quad \text{(A.5)}$$

. Substituting these into the objective function and differentiate w.r.t. q_0 yields the following FOC (assuming interior solution):

$$(1-p_H)\phi N q_0 - p_H h'(\frac{H}{p_H - p_L} - q_0 V_1^*)V_1^* = 0 \quad \text{(A.6)}$$

■

Proof of Proposition 3 (i) From Proposition 2, the risk aversion only affects q_0^* directly through $h'(.)$. If q_0^* increases as the agent gets more risk-averse, from (A.5) v_1^* decreases (and vice versa). Therefore, the threat of dismissal and bonus are substitute in risk-aversion.

(ii) Since (A.6) is increasing in q_0, if N (or ϕ) increases, q_0^* must decrease. Then, from (A.5) v_1^* has to increase.

Proof of Proposition 4 (i) Since $h'' > 0$, h'^{-1} is an increasing function. Also $(1 - \frac{f_L(y)}{fH(y)})$ is increasing in y due to the monotone likelihood assumption. Therefore, from (10), $q^*(y)$ is decreasing in y.

(ii) If Δ_t changes, λ also changes from the incentive constraint (8). Define $y^0(\lambda, \Delta_t)$ and $y^1(\lambda, \Delta_t)$ such that $q^*(y^0, \lambda, \Delta_t) = 0$ and $q^*(y^1, \lambda, \Delta_t) = 1$. Also define $\overline{y}$ such that $f_H(\overline{y}) = f_L(\overline{y})$. From (10), $y^1 < y^0 < \overline{y}$. Note that from the monotone likelihood assumption, $f_H(y) < f_L(y)$ if $y < \overline{y}$.

One can rewrite the incentive constraint (8) as follows:

$$
\begin{aligned}
IC(\lambda, \Delta_t) &\equiv \int [v^*(y; \lambda, \Delta_t) + (1 - q^*(y; \lambda, \Delta_t))V](f_H(y) - f_L(y))dy - H \\
&= \int_{y^1}^{y^0} (1 - q^*(y; \lambda, \Delta_t))V](f_H(y) - f_L(y))dy + \int_{y^0}^{\overline{y}} V(f_H(y) - f_L(y))dy \\
&\quad + \int_{\overline{y}}^{\infty} [v^*(y; \lambda, \Delta_t) + V](f_H(y) - f_L(y))dy - H \\
&= 0
\end{aligned}
$$

. Using the implicit function theorem, $\frac{\partial \lambda}{\partial \Delta_t} = -(\frac{\partial IC}{\partial \Delta_t})/(\frac{\partial IC}{\partial \lambda})$.

$$
\begin{aligned}
\frac{\partial IC}{\partial \lambda} &= \int [\frac{\partial v^*(y; \lambda, \Delta_t)}{\partial \lambda} - \frac{\partial q^*(y; \lambda, \Delta_t)}{\partial \lambda} V](f_H(y) - f_L(y))dy \\
&= -\int_{y^1}^{y^0} \frac{\partial q^*(y; \lambda, \Delta_t)}{\partial \lambda} V(f_H(y) - f_L(y))dy + \int_{\overline{y}}^{\infty} \frac{\partial v^*(y; \lambda, \Delta_t)}{\partial \lambda}(f_H(y) - f_L(y))dy \\
&= \int_{y^1}^{y^0} \frac{1}{\phi N} V^2 (1 - \frac{f_L(y)}{f_H(y)})(f_H(y) - f_L(y))dy + \int_{\overline{y}}^{\infty} h''(\lambda(1 - \frac{f_L(y)}{f_H(y)}))(1 - \frac{f_L(y)}{f_H(y)})(f_H(y) - f_L(y))dy \\
&> 0
\end{aligned}
$$

λ also changes y^0 and y^1. However, those terms get all cancelled out. The last inequality is due to $(1 - \frac{f_L(y)}{f_H(y)})(f_H(y) - f_L(y)) \geq 0$ with equality if $y = \bar{y}$ and $h'' > 0$.

$$
\begin{aligned}
\frac{\partial IC}{\partial \Delta_t} &= -\int_{y^1}^{y^0} \frac{\partial q^*(y; \lambda, \Delta_t)}{\partial \Delta_t} V(f_H(y) - f_L(y))dy \\
&= \int_{y^1}^{y^0} \frac{1}{\phi N} V(f_H(y) - f_L(y))dy < 0
\end{aligned}
$$

Again, the changes of y^0 and y^1 due to Δ_t gets all cancelled out. The last inequality is due to $f_H(y) - f_L(y) < 0$ for $y^1 \leq y \leq y^0$. Therefore,

$$
\frac{\partial \lambda}{\partial \Delta_t} = -(\frac{\partial IC}{\partial \Delta_t})/(\frac{\partial IC}{\partial \lambda}) > 0
$$

Proof of Proposition 5 The proof follows directly from the fact that $\sigma_{t+1}^2 = \frac{\sigma_t^2 \sigma_\varepsilon^2}{\sigma_t^2 + \sigma_\varepsilon^2} < \sigma_t^2$.

TABLE 1 Description of Variables and Summary Statistics

Variable	Description	Obs	Mean	Std. Dev.	5%	50%	95%
quit	=1 if worker is dismissed	3,231	0.32	0.47	0	0	1
educ	education (year)	3,045	12.92	1.57	12	12	16
age	age (year)	3,231	31.07	7.36	22	30	45
gender	=1 if female	3,231	0.91	0.29	0	1	1
marital	=1 if married	3,209	0.56	0.50	0	1	1
comp[a]	6-month compensation	10,522	10,995.87	2,797.37	7,850	10,287.54	16,246.77
totalw[b]	performance	112,071	174.01	108.04	23.52	159.19	359.52
tenure[c]	tenure (2-weeks)	112,071	118.88[d]	118.76	4	79	365

[a]: The compensation is the 6 month sum of salary, bonus, and overtime payments.

[b]: Totalw is the two-week average of the weighted number of claims processed a day.

[c] : Tenure is measured in units of two weeks.

[d] : Due to the right-censoring, the tenure average is underestimated.

TABLE 2 Termination Reasons

Termination Reason	Frequency	Percent
VOL: ENTERING NEW FIELD	132	12.8
VOL: FAMILY OBLICATIONS	86	28.4
VOL: SPOUSE RELOCATED	65	6.3
VOL: MORE MONEY	58	5.3
VOL: ADVANCEMENT OPPORTUNITY	55	5.3
VOL: JOB CONTENT	49	4.8
VOL: RETURNING TO SCHOOL	38	3.7
VOL: JOB ABANDONMENT	36	3.5
VOL: LOCATION	22	2.1
VOL: HEALTH	11	1.1
VOL: FAILED TO RETURN	10	1.0
VOL: WORKLOAD	6	0.6
VOL: JOB CHALLENGE	7	0.7
VOL: COMMUTING DIFFICULTIES	5	0.5
VOL: CONFLICT W/ SUPERVISOR	3	0.3
VOL: BENEFITS	1	0.1
VOL: WORKING CONDITIONS	3	0.3
VOL: OTHER	87	8.4
VOL: TOTAL	674	65.5
INVOL: PERFORMANCE	162	15.7
INVOL: PUT ON PROBATION	45	4.4
INVOL: JOB ELIMINATED	41	4.0
INVOL: ATTENDANCE	34	3.5
INVOL: UNETHICAL CONDUCT	8	0.8
INVOL: VIOLATION OF PUBLISHED RULES	4	0.4
INVOL: FRAUD OR DISHONESTY	3	0.3
INVOL: OTHERS.	59	5.7
INVOL: TOTAL	355	34.5
TOTAL	1,029	100

TABLE 3 Duration Estimation

(a) Weibull regression - log relative-hazard form

	Termination	Voluntary Termination				Invol. Term.
	All	All	New Field	Advance Opp.	More Money	All
age	-.0728359	-.0911037	-.0704647	-.0734226	-.1202535	-.0425799
	(.0056409)	(.007247)	(.0156087)	(.0243278)	(.0272874)	(.00906)
educ	.0536344	.1205562	.2069113	.2643293	.1657378	-.0936244
	(.0206027)	(.024278)	(.0503716)	(.0768247)	(.0800705)	(.0395796)
gender	-.4008469	-.0741416*	-.5353928	.6776729*	-.4656307*	-.9284194
	(.1030531)	(.1410856)	(.253143)	(.6043372)	(.3968965)	(.1529677)
marital	-.2514599	-.0556914*	-.3039017	-.545249	-.5450827	-.6243338
	(.0664681)	(.0825041)	(.1837021)	(.2848876)	(.2842997)	(.1134897)
constant	-2.62294	-3.568725	-6.138011	-9.05109	-5.313582	-2.578331
	(.3338778)	(.4082386)	(.8545846)	(1.402144)	(1.344739)	(.6007467)
1/p	1.262804	1.337929	1.445281	1.299906	1.298049	1.118361
	(.034127)	(.0452285)	(.1103349)	(.1522976)	(.1499006)	(.0501382)
#(T=1)[a]	1025	674	132	55	58	351
#(obs)[b]	3014	3014	3014	3014	3014	3014

* : NOT significant at 10%.

[a] : T=1 if the employment contract is terminated during the sample period, =0 otherwise.

[b] : The number of observations is smaller than the full sample due to the missing variables in educ and marital and 3 subjects who quit immediately.

(b) Summary Statistics of the Predicted Median Duration[a]

Mean	Std. Dev.	5%	50%	95%
314.5441	357.0658	80.03063	201.7645	902.8869

[a] : From the estimation using all termination.

TABLE 4 Duration Estimation

(a) Weibull regression - log relative-hazard form

	Termination	Voluntary Termination				Invol. Term.
	All	All	New Field	Advance Opp.	More Money	All
age	-.0237123	-.0368214	-.012099*	-.0226675*	-.0543648	-.0020964
	(.0051012)	(.0065724)	(.0141089)	(.0216976)	(.0247611)	(.0081787)
educ	.0459869	.1059142	.1974513	.2622243	.1590039	-.0937383
	(.0206658)	(.0243119)	(.050519)	(.0777068)	(.0801252)	(.039915)
gender	-.5283936	-.1637483*	-.6567704	.5315875*	-.557754*	-1.14963
	(.1033624)	(.1411192)	(.254309)	(.6065735)	(.3983572)	(.1549118)
marital	-.214919	-.0102462*	-.3136063	-.5411127	-.5182789	-.6180923
	(.0668948)	(.0829292)	(.185048)	(.2876752)	(.2859213)	(.11485)
mean(totalw)	-.0058917	-.0052626	-.0033661	-.0089419	-.0073985	-.007084
	(.0005153)	(.0006305)	(.0013703)	(.0023347)	(.0022952)	(.0008886)
mean(salary)	-.0002713	-.0002849	-.0003283	-.0002858	-.0002933	-.0002571
	(.0000107)	(.0000137)	(.0000315)	(.0000474)	(.0000503)	(.0000175)
constant	.7002321	-.045638	-2.215141	-5.302733	-1.89506*	.5808922*
	(.3577929)	(.4440372)	(.9569837)	(1.531356)	(1.476001)	(.6293001)
1/p	.8981178	.9682684	1.035153	.9005015	.9291809	.7719394
	(.1295925)	(.1519469)	(.2785422)	(.4251976)	(.3968042)	(.204229)
#(T=1)[a]	1025	674	132	55	58	351
#(obs)[b]	3014	3014	3014	3014	3014	3014

* : NOT significant at 10%.

[a] : T=1if the employment contract is terminated during the sample period, =0 otherwise.

[b] : The number of workers is smaller than that of the full sample due to the missing variables in educ and marital and a few workers who quit immediately.

(b) Summary Statistics of the Predicted Median Duration[a]

Mean	Std. Dev.	5%	50%	95%
670.6105	3894.21	33.36258	109.1832	2813.282

[a] : From the estimation using all termination.

TABLE 5 Productivity and Tenure

	OLS		Random-Effect		Fixed-Effect
tenure	.632455	.6016307	.813629	.8059477	.7221746
	(.0079041)	(.0079692)	(.0180588)	(.0180994)	(.030383)
tenure^2	-.0009719	-.000923	-.0016582	-.0016549	-.0018617
	(.0000182)	(.0000183)	(.0000416)	(.0000416)	(.0000471)
age	-.8144315	-.7931233	-1.07978	-1.01773	.8763543*
	(.0513373)	(.0512177)	(.215501)	(.2150634)	(.6282728)
edu	-.1208695*	-.3273208*	.4105862*	.2886795*	
	(.2099944)	(.2096282)	(.9645939)	(.9638908)	
gender	9.992435	7.585263	10.67372	8.388098*	
	(1.210798)	(1.210881)	(5.295515)	(5.298054)	
marital	-.1512363*	-.5644325*	5.087046	4.245774*	
	(.6658425)	(.6644266)	(3.07123)	(3.066882)	
vol:term[a]		-18.49379		-14.8958	
		(1.00882)		(3.750551)	
invol:term[b]		-30.35888		-24.6633	
		(1.335113)		(4.916678)	
#(obs)	103,645	103,645	103,645	103,645	103,645

* : NOT significant at 10%.

[a] : vol:term$_i$ = 1 if a worker i quits voluntarily, =0 otherwise.

[b] : invol:term$_i$ = 1 if a worker i quits involuntarily, =0 otherwise.

TABLE 6 Probit Estimation

(dependent variable: $T_{it} = 1$ if worker i quits at time t, $= 0$ otherwise)[a]

	Termination	Voluntary Termination				Invol. Term.
	All	All	New Field	Advance Opp.	More Money	All
tenure	-.0000141*	-.0009207	-.000688*	-.0009204*	-.000827*	.0007529
	(.0002757)	(.0003867)	(.0008315)	(.0011119)	(.0012122)	(.0003422)
totalw	-.0015493	-.0011168	.0001402*	-.0011723*	-.0012281*	-.0022846
	(.0002218)	(.0002535)	(.0004727)	(.0007518)	(.0007558)	(.0003726)
tenure*totalw	-.0000122	-.0000111	-.0000219	-.0000105*	-.0000141*	-9.25e-06
	(2.05e-06)	(2.77e-06)	(6.68e-06)	(8.70e-06)	(.0000103)	(2.64e-06)
educ	-.0005348*	.0218312	.0493558	.0631546	.0294179*	-.0474445
	(.0079387)	(.0090211)	(.0162608)	(.0230748)	(.0238106)	(.013321)
age	.0036811	.0007969*	.0092592	.0069157*	-.0034286*	.0085876
	(.0019037)	(.0022743)	(.0042431)	(.0060582)	(.0066315)	(.0028108)
gender	-.1236355	.0087743*	-.1644417	.2172539*	-.1077782*	-.2996957
	(.0409142)	(.0519741)	(.0822748)	(.1719492)	(.1191502)	(.055529)
marital	-.0529662	.0223651*	-.0639321*	-.1222245*	-.1316018*	-.1805153
	(.025484)	(.0300893)	(.0578565)	(.0825571)	(.0825173)	(.0389989)
constant	-1.915419	-2.443572	-3.506502	-4.106648	-3.020818	-1.643303
	(.1295925)	(.1519469)	(.2785422)	(.4251976)	(.3968042)	(.204229)
#(T=1)	1029	677	132	55	58	352
#(obs)	103,645.	103,645.	103,645.	103,645.	103,645.	103,645.

[*] : NOT significant at 10%.

[a] : time is in units of two-weeks.

[b] : totalw is measured by the two-weeks average.

TABLE 7 Probit Estimation with Random Effect

(dependent variable: $T_{it} = 1$ if worker i quits at time t, $= 0$ otherwise)[a]

	Termination	Voluntary Termination				Invol. Term.
	All	All	New Field	Advance Opp.	More Money	All
tenure	-.0011914	-.0022464	-.0016043 *	-.0019075	.0046144*	.0005199*
	(.0004179)	(.0005589)	(.0014341)	(.0016668)	(.003166)	(.0005558)
tenure^2	3.31e-06	4.08e-06	3.02e-06 *	3.26e-06 *	-.0000282*	6.32e-07*
	(8.81e-07)	(1.23e-06)	(3.73e-06)	(4.01e-06)	(.0000172)	(1.19e-06)
totalw	-.0014605	-.0010357	.0001284 *	-.0011061*	-.0013846*	-.0022533
	(.0002177)	(.0002466)	(.0004631)	(.0007322)	(.0008828)	(.0003749)
tenure*totalw	-.0000118	-.0000105	-.0000204	-.00001*	-.0000192*	-9.28e-06
	(1.96e-06)	(2.59e-06)	(6.70e-06)	(8.13e-06)	(.0000144)	(2.62e-06)
educ	-.0007572	.0214914	.049296	.0630547	.0310651*	-.0474185
	(.0079461)	(.0090307)	(.0162651)	(.0230814)	(.0239122)	(.0133205)
age	.0038001	.0007922*	.0092634	.0069049*	-.0027167*	.0086418
	(.0019057)	(.0022775)	(.0042465)	(.0060675)	(.0066283)	(.0028126)
gender	-.1211855	.011446*	-.1638098	.2200733*	-.1136614*	-.2991584
	(.0409752)	(.0520597)	(.0822961)	(.1722057)	(.1191455)	(.0555494)
marital	-.0508301	.0247908*	-.0629314*	-.1205075*	-.1353285*	-.1800214
	(.0255336)	(.0301549)	(.0579179)	(.082677)	(.0826809)	(.0390228)
constant	-1.89211	-2.415458	-3.488561	-4.090943	-3.137014	-1.640344
	(.1299205)	(.1523823)	(.2795698)	(.4258669)	(.4036048)	(.2043405)
#(T=1)	1029	677	132	55	58	352
#(obs)	103,645.	103,645.	103,645.	103,645.	103,645.	103,645.
#(group)	3017	3017	3017	3017	3017	3017

* : NOT significant at 10%.

[a] : time unit is two-weeks.

[b] : totalw are measured by two-weeks average.

TABLE 8 Performance Variance and Tenure

(dependent variable=variance of performance[a])

	sample variance	N*sample variance
tenure	71.388595	794.54219
	(12.9354334)	(142.724681)
$tenure^2$	-1.411783	-15.31573
	(0.4014497)	(4.429445)
age	-21.265205	-240.68075
	(6.5308037)	(72.058418)
educ	-24.233172*	-124.86846*
	(26.7535178)	(295.188199)
gender	-87.097286*	-678.07411*
	(156.7534999)	(1729.558841)
marital	-160.633166	-1580.99743
	(84.9844460)	(937.686240)
#(obs)	9490	9490
R^2	0.0057	0.0057

* : NOT significant at 10%.

[a] : The variance of performance is computed as the individual variance of two-week average totalw over 6-month tenure period.

TABLE 9 Wage Regression[a]

(dependent variable=wage[b])

	(1)	(2)
tenure	411.047203	173.95313
	(5.6860167)	(6.2118871)
tenure^2	-7.255769	-2.82300
	(0.1730935)	(0.1629868)
totalw	3.755752	0.86343
	(0.2475309)	(0.2132561)
totalw*tenure	0.122374	0.19146
	(0.0166859)	(0.0139844)
educ	116.473278	88.83318
	(10.5012037)	(8.6793922)
age	-1.188885*	7.50624
	(2.5661446)	(2.1220857)
level[c] (=1)		-3325.25335
		(52.2181142)
(=2)		-2660.78623
		(45.7229006)
(=3)		-1432.22857
		(40.6578332)
(=4)		0
R^2	0.685094	0.785939
#(obs)	9,925	9,925

* : NOT significant at 10%.

a : The regression runs included time, gender, and marital dummy variables which are not reported in the table above.

b : The wage is measured by the sum of 6-month salary, bonus, and overtime payment.

c : The level indicates the job hierarchy levels. There are four hierarchy levels.

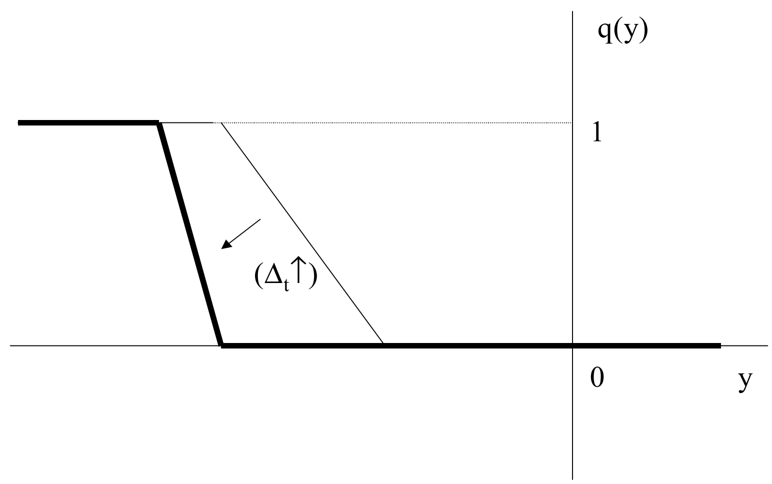

Figure 1 Dismissal Probability and Tenure under a Incentive Model

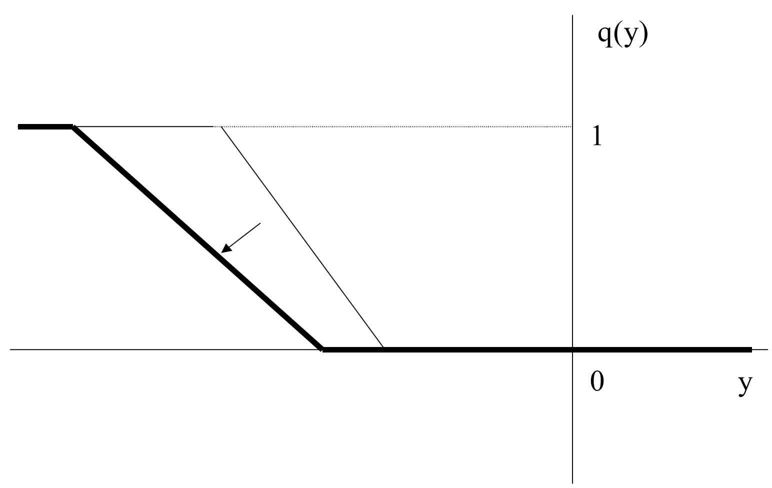

Figure 2 Dismissal Probability and Tenure under a Sorting Model

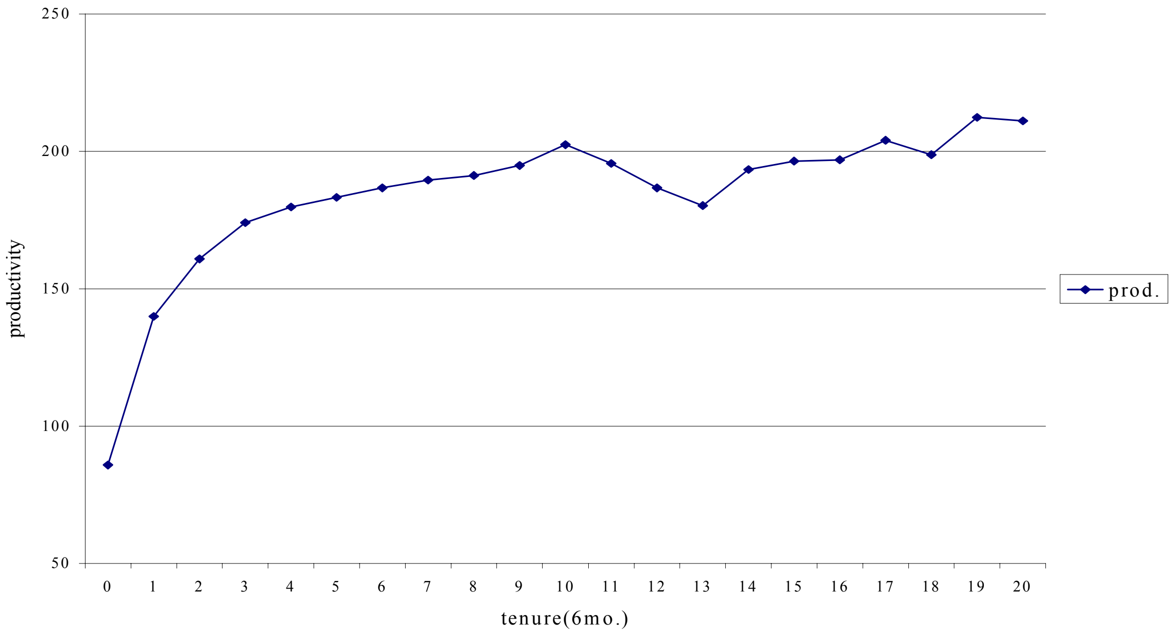

Figure 3 Productivity and Tenure