Why do Wages become More Rigid during a Recession than during a Boom?[1]

Izumi Yokoyama

June 1, 2014

[1]This research is supported by the Grant-in-Aid for Scientific Research (#25885033, PI: Izumi Yokoyama). This paper is based on one chapter of my dissertation at the University of Michigan. I wish to thank all the members of my dissertation committee—Charles Brown, James Hines, Melvin Stephens, and Mary Corcoran—for the constant support they gave me as I worked on completing this paper. I also want to acknowledge Michael Elsby for the many comments he gave me when I developed this as my third-year paper. I also appreciate the feedback I received from the participants at Tokyo Labor Economics Workshop at the University of Tokyo, GSE-OSSIP Joint Seminar in Economics at Osaka University, and Contract Theory Workshop East (CTWE) at Hitotsubashi University. This paper was originally developed from my master's thesis, and I am also grateful to my primary advisor in my master's program at Hitotsubashi University, Isao Ohashi, and other professors who left many comments on the preliminary version of this paper—Daiji Kawaguchi, Ryo Kambayashi, and Hiroyuki Odagiri. I also thank the 21st Century Center of Excellence Program at Keio University for providing the Keio Household Panel Survey data.

Abstract

This paper provides a theoretical and empirical analysis of the effect of performance-based layoffs on wage rigidity in the context of performance pay. In the model, it becomes optimal for firms to raise future regular pay to maintain workers' current efforts, which results in the downwardly rigid regular pay of experienced employees under the threat of performance-based layoffs. Together with the finding that layoffs are more likely to occur during recessions, this result has an implication on the downward rigidity of regular pay during recessions. Furthermore, it becomes optimal for firms to base wages less on workers' performance during recessions due to the lower value of productivity. As a result, wages during recessions also become "rigid" (inflexible) with respect to performance. The results from a Japanese panel dataset supported these theoretical implications.

JEL Classification: J30, J33, J63
Keywords: Wage Rigidity; Performance Pay; Performance-based Layoffs

Izumi Yokoyama
Faculty of Economics
Hitotsubashi University
2-1 Naka, Kunitachi
Tokyo 186-8601, Japan
izumi.yokoyama@r.hit-u.ac.jp
Tel: +81-42-580-8598
Fax: +81-42-580-8598

1 Introduction

When unemployed workers are available, why do firms not cut wages until the excess supply is eliminated, as is expected in the ideal market scenario depicted by conventional theory? This question has puzzled many economists, and a number of studies have attempted to solve the dilemma. Noteworthy among these are the efforts of Bewley (1999), who conducted commendable field research and provided us with a clue to the answer. In his research, Bewley (1999) found that no existing theories on wage rigidity correctly explained his findings in the "real" U.S. labor market, which implies the need for a new theoretical model.

One of the reasons why research on wage rigidity during a recession is important is that wages during a recession could help reduce high unemployment. Theoretically, firms could hire more people by paying lower wages to existing workers, and if wages do not fall during a recession, this may prevent new workers from being hired. Thus, if there is a particular reason why wages do not fall during a recession, it would be worthwhile understanding the possible sources of such wage rigidity.

In this study, I explore the mechanism in which nominal wages become downwardly rigid during a recession (but not during a boom) by showing that firms have a reason to resist cutting nominal pay during a recession. To do so, I construct a new model incorporating the findings of Bewley (1999) on the difference in layoff criteria between the non-unionized and unionized workers. According to Bewley (1999), 28% (86%) of non-union (unionized) workers are laid off based on inverse seniority, while 57% (7%) of non-union (unionized) workers are laid off based on performance.[1] To capture these widely observed practices, I adopt a model in which firms decide how much weight they put on performance (or seniority) as a layoff criterion, rather than using the "minimum effort standard."[2] In this way, it becomes possible

[1]The remaining category is "both performance and inverse seniority," which accounts for 7% of unionized workers and 13% of non-union workers.

[2]In most economic models, firms lay off their workers either randomly or based on seniority. For example, Baily (1977) and Macleod et al. (1994) present models in which firms lay off workers randomly, while Grossman (1983) and Reagan (1992) assume seniority-based layoffs. Nosal (1990), Strand (1991), and Strand (1992) consider both types of layoffs. Laing (1994) and Gibbons and Katz (1991) propose signaling models, in which firms may choose to lay off workers according to observed ability. Ioannides and Pissarides

to allow the layoff criteria to differ between unionized workers and non-union workers, and in my model, layoffs can occur only during a recession in equilibrium. Consequently, unlike the typical efficiency wage (such as in Shapiro and Stiglitz (1984) and Sparks (1986)), in which an equilibrium with no dismissals is derived, I am able to answer the following question: Why do wages not fall during recessions in which firms lay off many workers, thereby creating high unemployment?[3]

In addition, recently, performance-based pay has been employed in many countries. For example, Lemieux et al. (2009) show that, in the U.S., the proportion of performance-paid jobs is increasing. Moreover, the "pay-for-performance" system has become widespread in many countries since the 1990s. This is particularly so in Japan, where most employees traditionally receive a substantial portion of their pay in the form of bonuses. In Japan, the amount paid as a bonus generally fluctuates, depending on the firm's and the worker's performance. Thus, particularly for countries such as Japan, it is important to assume performance-based pay rather than fixed wages. Given this scenario, the model presented in this study divides a worker's total compensation into two components: a fixed component (regular pay) and a performance-based pay component (bonus). This division makes it possible to determine how each component contributes to wage rigidity during a recession.

Third, according to Bewley (1999), the key reason for a firm's reluctance in cutting wages is the belief that nominal wage cuts damage worker morale. This finding implies that while modeling nominal downward wage rigidity, it might be better to allow wages to positively affect workers' performance. The model presented in this study allows interactions between wages and workers' efforts both over periods and within periods. Since a fixed component

(1983) present a model in which a firm decides to lay off a worker based on the information about an external offer to the worker.

[3]In Shapiro and Stiglitz (1984), the dismissal rule is given exogenously, and workers caught shirking are fired, regardless of market conditions. Sparks (1986) further developed the rule of Shapiro and Stiglitz (1984) by making both workers' levels of effort and the criterion for dismissal endogenous. In Sparks' model, it is assumed that workers who provide effort equal to or above the minimum standard are never dismissed, and a firm offers workers a labor contract that specifies both their wage and the required minimum effort standard. In equilibrium, workers' efforts are set equal to the minimum effort standard. This yields no dismissals, regardless of market conditions, as Shapiro and Stiglitz (1984) demonstrated.

and a performance-based pay component play different roles in inducing high levels of efforts in a multiple-period model setting, in this paper, the difference in the manner in which the two components contribute to wage rigidity is explained.

The main results obtained from the theoretical model are as follows: (a) performance-based layoffs are more likely to occur when the layoff costs and the output price are low; (b) experienced employees' regular pay is likely to be downwardly rigid during periods in which performance-based layoffs occur; and (c) bonuses move proportionally to the output price. Together with result (a), result (b) implies the downward rigidity of regular pay during a recession: wages scheduled to be paid during a recession will affect new employees' levels of effort because, given the possibility of being laid off, new employees will only receive wages in the second period if they work hard in the first period and avoid being laid off. This gives the firm an incentive to raise workers' future regular pay to maintain their current level of effort, which results in downwardly rigid regular pay during a recession. In contrast, experienced employees' wages during periods in which the output price is high enough for performance-based layoffs to not occur, do not affect new employees' efforts. This is because new employees will necessarily receive their wages without being laid off in the next period, regardless of their current levels of effort. Given these facts, firms set a higher lower-bound for regular pay paid to experienced employees during periods in which the output price is low enough for layoffs to occur, creating downward wage rigidity during a recession.

The rationale behind result (c) is as follows. During a recession, the lower value of productivity discourages firms from maintaining workers' current incentives at a high level, which results in lower bonuses during a recession. As a result, wages during recessions also become "rigid" (inflexible) with respect to performance.

To test the theoretical implications obtained from my model, I conduct an empirical analysis using Japanese panel data from the Keio Household Panel Survey (KHPS), 2004–2007. There are two steps in the evaluation of the theoretical model. The first step is a layoff regression, employed to confirm that performance-based layoffs are more likely to occur during a recession when the output price is low and for non-union workers whose performance-based layoff costs are relatively low. The second step is a wage regression. This step shows that regular pay becomes downwardly rigid when performance-based layoffs are likely to occur (i.e., for non-union workers during a recession), and that bonuses only move proportionally to the output price.

2 Basic Model

2.1 Model Structure

Worker Types

It is assumed that there are only two types of workers in each firm: new employees and experienced employees. Workers who have been recently recruited by a firm are categorized as new employees, and workers who have continued with the same employer are categorized as experienced. Here, for simplicity, I further assume that workers have a two-period time horizon. In the first period, they join a firm as a new employee. In the second period, they either remain with the same employer as an experienced employee or are laid off at the beginning of the second period.[4]

Output Price

It is assumed that firms are price-takers and that the output price is drawn randomly from a distribution, $G(p)$, with density function $G(p) > 0$ for $p \in [p^-, p^+]$. Thus, the output price is assumed to be *i.i.d.*, and thus a higher value of p_t does not lead the firm (or others) to expect a higher value of p_{t+1}.

[4] In this model, it is assumed that workers recently employed by a firm are not laid off. The firm thus controls the entire labor force by adjusting the number of new employees and the number of experienced employees who are laid off.

Wages

A worker's wage is divided into two components, namely a fixed pay component and a performance-based pay component. These components for each type of workers are expressed as follows:

$$w_N(p_t) = a_N(p_t) + b_N(p_t)\, e_N \tag{1}$$

$$w_E(p_t) = a_E(p_t) + b_E(p_t)\, e_E, \tag{2}$$

where a represents regular (fixed) pay and b represents the "piece rate" paid for each unit of effort, e. Hereafter, the subscripts N, E represent the types of workers, namely new employees and experienced employees, respectively. I further assume that both a and b are contingent on the output price, p_t, and that the contract specifies a_N, a_E, b_N, and b_E for each realization of p_t.[5]

Layoffs

When a firm uses workers' "performance" as a criterion for layoffs, the probability of a worker being laid off is a decreasing function of the effort offered by the same worker in the previous period. In contrast, if the firm uses "seniority" as a criterion for layoffs, an experienced worker will not be laid off, with a probability of 1. Here, It is assumed that the firm can choose how much weight to place on performance while choosing the layoff criterion. Let $\gamma \in [0,1]$ denote this weight. Furthermore, γ is also contingent on the output price, p_t (i.e., $\gamma(p_t)$).

Then, the probability of a worker being retained in the firm is expressed as:

$$\gamma(p_t) \cdot min\left(\frac{e_N}{\bar{e}}, 1\right) + (1 - \gamma(p_t)) \cdot 1 \tag{3}$$

[5]Note that in a sense that the firm can observe workers' performance and thus can base wages on performance, the motivation for using the threat of layoffs as an incentive tool is different from the typical efficiency wage model. In this model, the reason for using the threat of layoffs does not stem from imperfect monitoring, but instead should be understood as the firm's strategy when both incentive tools—threat of performance-based layoffs and performance-based pay—are available.

It is assumed that $\bar{e}$ is given exogenously, while γ is chosen by the firm for each realization of p_t. Note that a higher value of γ means a worker faces a greater risk of being laid off. If $\gamma = 1$, the layoff decision is completely performance based, and experienced employees will be laid off with a probability of $(1 - e_N/\bar{e})$. Note that a "completely performance-based" layoff decision does not mean that the firm lays off all workers whose effort in the first period was less than $\bar{e}$.[6] This means that an increase/decrease in e_N will be fully reflected in the layoff probability. For $\gamma \in [0, 1]$, changes in the level of effort will be partially reflected in the layoff probability. If $\gamma = 0$, the layoff decision is completely seniority based, and thus, an experienced worker who has already worked for one period will be retained with probability 1. In this case, changes in the level of effort do not affect the layoff probability.

Timing

The timing of events is as follows:

1. The output price, p_t, is observed by both the firm and its workers.

2. Each firm offers a contingent labor contract to new employees.

3. New employees decide whether to accept or reject the firm's offer. Experienced employees also decide whether to stay in the same firm.

4. Both new employees and experienced employees who continue with the firm exert effort, production occurs, profits are realized, and payments are made.

5. In the case of $\gamma > 0$, workers are laid off with a probability of $\gamma(p_{t+1})(1 - e_N/\bar{e})$. If not laid off, workers who have finished their first period at the firm become new

[6]Within this "completely performance-based" layoff case, the layoff probability function $d = (1 - e_N/\bar{e})$ is the same as that defined in Sparks (1986). The layoff rule is different from Sparks (1986)'s in that I consider a weight put on each of the two layoff criteria and endogenize it. The reason for employing this layoff function should be understood as the firm announcing the rule as a strategy to induce high effort levels from workers. Accordingly, the layoff probability is decreasing in effort and this does not stem from imperfect monitoring as in Sparks (1986).

experienced employees. The current experienced employees, who have now finished their second period at the firm, retire.

2.2 Workers

It is assumed that all workers are identical in that they possess the same skills and utility functions. I assume a worker's utility to be increasing in wage income, w, and decreasing in the level of work effort, e. Therefore, the posited utility function is:

$$Utility = w - e^2 \tag{4}$$

Let V^E be the discounted expected lifetime utility for a new employee employed in period t. Assuming that a worker is paid wages at the end of a period, V^E is given by:

$$V_t^E = a_N(p_t) + b_N(p_t)\,e_N - e_{N,t}^2 + \delta \int_p \left\{ \begin{array}{l} \left(\gamma(p) \cdot min\left(\frac{e_N}{\bar{e}}, 1\right) + 1 - \gamma(p)\right) \times \\ max\left\{a_E(p) + b_E(p)e_E - e_E^2, U\right\} \\ +\gamma(p) \cdot \left(1 - min\left(\frac{e_N}{\bar{e}}, 1\right)\right) U \end{array} \right\} dG(p) \tag{5}$$

where U is the unemployment insurance benefit, which is exogenously given.[7] Workers who have completed the first period are allowed to quit the firm if the utility for the second period, calculated based on the output price p_{t+1}, is lower than U. Given the contract proposed by a firm, each employed worker decides on how much effort to invest in his/her current job to maximize his/her expected lifetime utility.[8] Experienced employees are better protected against permanent layoffs under seniority-based layoffs than under performance-based layoffs. To capture this fact, it is assumed that the exogenous variable $\bar{e}$ is large enough to ensure that the internal solution for e_N^* is always less than $\bar{e}$, which results in $e_N^*/\bar{e} < 1$.

[7] In this study, It is assumed that all workers have the same ability and skill, and thus there is no room for the sort of inference that arises in the "career-concern" models, in which a worker's outside option in the second period depends on the market's estimate of the worker's ability. Therefore, U does not depend on the level of effort in the first period, as it usually does in "career-concern" models.

[8] Note that the worker never has an incentive to supply an effort beyond $\bar{e}$, because this would bring about disutility without decreasing the probability of being laid off.

Then, solving the first-order conditions, the effort supply functions can be written as:

$$e_N^* = \frac{1}{2}b_N + \frac{1}{2}\delta E \left[max \left\{ \frac{\gamma(p)}{\bar{e}} \left(a_E(p) + b_E(p)e_E - e_E^2 - U \right), 0 \right\} \right] \quad (6)$$

$$e_E^* = \frac{1}{2}\, b_E \quad (7)$$

Eq.(6) and Eq.(7) show that workers' current levels of effort depend on the current piece rate, b; in other words, e_N^* and e_E^* increase in b_N and b_E, respectively. However, it is more important to note that as long as a firm pays wages that are higher than those necessary to keep workers during the second period, the effort of a new employee, e_N, will also depend on the wages scheduled to be paid in the next period after performance-based layoffs have occurred (i.e., $\gamma(p) > 0$). In other words, in deciding on an optimal level of effort, new employees consider the future wage they will receive during periods in which performance-based layoffs occur. This is because, given the possibility of being laid off, new employees will receive wages in the second period only if they work hard in the first period and avoid being laid off. Then, higher wages paid to experienced employees during "performance-based layoff periods" encourage new employees to work hard.

In contrast, experienced employees' wages during periods in which performance-based layoffs do not occur (i.e., wages with $\gamma(p) = 0$), do not affect new employees' efforts. This is because new employees will necessarily receive their wages without being laid off, regardless of their current levels of effort. Thus, when $\gamma(p) = 0$, only the current piece rate can affect new employees' incentives.

For example, if performance-based layoffs occur only in a recession, wages scheduled to be paid during a recession will affect new employees' levels of effort, while wages scheduled to be paid during booms will not.

In addition, since experienced workers are assumed to retire after the second period, only the current "piece rate" induces effort from experienced employees, as there is no threat of future layoffs. Eq.(7) explains this result.

2.3 Firms

Let C be the exogenous costs associated with laying off a worker. Note that in this model, it is assumed that workers who were recently employed by a firm are not laid off. This simplification makes the "seniority-based layoffs" equivalent to "no layoff of experienced workers."[9] Thus, layoff costs (C) are also equivalently treated as the costs of performance-based layoffs.

The expected profits from hiring a worker at period t can be written as:

$$\Pi_t = p_t e_N - a_N(p_t) - b_N(p_t)\, e_N + \delta \int_p \left\{ \begin{array}{l} \left(\gamma(p)\frac{e_N}{\bar{e}} + 1 - \gamma(p)\right) \\ \times \left(p_{t+1} e_E - a_E(p) - b_E(p) e_E\right) \\ -C\gamma(p)\left(1 - \frac{e_N}{\bar{e}}\right) \end{array} \right\} dG(p) \tag{8}$$

The firm offers a new employee hired in period t, a contingent contract X_t=($a_N, b_N, \gamma(p_{t+1})$, $a_E(p_{t+1})$, $b_E(p_{t+1}); \forall p_{t+1}$) to maximize profit subject to providing workers with a competitively determined utility level. Then, the firm's problem can be written as follows:

$$\begin{array}{l} Max_{(X_t)} \Pi_t \\ s.t. \left\{ \begin{array}{l} V^E \geq V^U \\ a_E(p_{t+1}) + b_E(p_{t+1}) e_E - e_E^2 \geq U \quad \forall\, p_{t+1} \\ e_N^* = e(b_N, \gamma, \bar{e}, a_E, b_E, U) \\ e_E^* = e(b_E) \\ \gamma(p_{t+1}) \geq 0 \;\; \forall\, p_{t+1} \\ \gamma(p_{t+1}) \leq 1 \;\; \forall\, p_{t+1} \end{array} \right. \end{array} \tag{9}$$

Let $\lambda_1 \geq 0$ and $\lambda_2(p_{t+1}) \geq 0\, \forall\, p_{t+1}$ be the Kuhn-Tucker multipliers associated with the

[9]As Nosal (1990) also assumes, "seniority-based layoffs (layoffs by inverse-seniority)" means here that the possibility for experienced workers to be laid off is zero. It would be also possible to pose a restriction that junior workers are not hired during periods in which experienced workers are laid off. However, the object of this paper is to classify periods by the layoff possibility of senior workers, rather than delving into specifics regarding the definition of each layoff type. Thus, the term "seniority-based layoffs" in this paper should be understood as a situation where the layoff probability of senior workers is automatically set at zero (regardless of their performance, market conditions, and the number of new hires).

participation constraints for new employees and experienced employees, respectively. $\mu_1 \geq 0$ and $\mu_2(p_{t+1}) \geq 0 \; \forall \, p_{t+1}$ are the Kuhn-Tucker multipliers associated with $\gamma_{t+1}(p_{t+1}) \geq 0$ and $\gamma_{t+1}(p_{t+1}) \leq 1 \, \forall \, p_{t+1}$, respectively.

The first-order conditions are as follows:

$$\frac{\partial \mathcal{L}}{\partial a_N} = -1 + \lambda_1 = 0 \tag{10}$$

$$\frac{\partial \mathcal{L}}{\partial b_N} = -e_N + \lambda_1 e_N + \frac{\partial \mathcal{L}}{\partial e_N}\frac{\partial e_N}{\partial b_N} = 0 \tag{11}$$

$$\begin{aligned} \frac{\partial \mathcal{L}}{\partial a_E} &= -\delta\left(\gamma(p_{t+1})\frac{e_N}{\bar{e}} + 1 - \gamma(p_{t+1})\right) g(p_{t+1}) + \lambda_1 \delta \left(\gamma(p_{t+1})\frac{e_N}{\bar{e}} + 1 - \gamma(p_{t+1})\right) g(p_{t+1}) \\ &\quad + \lambda_2(p_{t+1}) + \frac{\partial \mathcal{L}}{\partial e_N}\frac{\partial e_N}{\partial a_E} = 0 \;\; \forall \, p_{t+1} \end{aligned} \tag{12}$$

$$\begin{aligned} \frac{\partial \mathcal{L}}{\partial b_E} &= \delta\left(\gamma(p_{t+1})\frac{e_N}{\bar{e}} + 1 - \gamma(p_{t+1})\right)\left((p_{t+1} - b_E)\frac{\partial e_E}{\partial b_E} - e_E\right) g(p_{t+1}) \\ &\quad + \lambda_1 \delta \left\{ \left(\gamma(p_{t+1})\tfrac{e_N}{\bar{e}} + 1 - \gamma(p_{t+1})\right)\left((b_E - 2e_E)\tfrac{\partial e_E}{\partial b_E} + e_E\right) \right\} g(p_{t+1}) \\ &\quad + \lambda_2(p_{t+1})\left((b_E - 2e_E)\frac{\partial e_E}{\partial b_E} + e_E\right) + \frac{\partial \mathcal{L}}{\partial e_N}\frac{\partial e_N}{\partial b_E} = 0 \;\; \forall \, p_{t+1} \end{aligned} \tag{13}$$

$$\begin{aligned} \frac{\partial \mathcal{L}}{\partial \gamma_{t+1}} &= \delta\left(\frac{e_N}{\bar{e}} - 1\right)(p_{t+1}e_E - a_E - b_E e_E + C)\, g(p_{t+1}) \\ &\quad + \lambda_1 \delta \left(\frac{e_N}{\bar{e}} - 1\right)\left(a_E + b_E e_E - e_E^2 - U(p)\right) g(p_{t+1}) \\ &\quad + \frac{\partial \mathcal{L}}{\partial e_N}\frac{\partial e_N}{\partial \gamma_{t+1}} + \mu_1(p_{t+1}) - \mu_2(p_{t+1}) = 0 \qquad \forall \, p_{t+1} \end{aligned} \tag{14}$$

From Eq.(10), we get:

$$\lambda_1 = 1 \tag{15}$$

Substituting Eq.(15) and $\partial e_N / \partial b_N = 1/2$ into Eq.(11) yields:

$$\frac{\partial \mathcal{L}}{\partial e_N} = 0 \tag{16}$$

By substituting Eqs.(15) and (16) into Eq.(12), we have

$$\lambda_2(p_{t+1}) = 0 \quad \forall\, p_{t+1} \tag{17}$$

This means that the no-quit constraint for experienced employees is not binding. Thus, as long as the firm solves the optimization problem presented in Eq.(9), the no-quit constraint is automatically satisfied, and workers will never quit even without the no-quit constraint.

Proposition 1 *Experienced workers are always paid higher wages than they would earn as a result of the outside option. In other words, the following condition is always satisfied:*

$$a_E(p_{t+1}) + b_E(p_{t+1})e_E - e_E^2 > U \quad \forall\, p_{t+1} \tag{18}$$

Proof of Proposition 1

Suppose that a firm paid just the necessary level of wages to keep workers during the second period. Then, the firm could be better off by increasing $b_E(p_{t+1})$ by a small amount and decreasing $a_E(p_{t+1})$ by an amount so that these changes still satisfy $a_E(p_{t+1})+b_E(p_{t+1})e_E-e_E^2 = U$. This is because if the firm paid just the necessary amount to keep workers during the second period, future wages should not affect the incentives for new employees due to Eq.(6). Therefore, decreasing $a_E(p_{t+1})$ would not affect new employees' efforts but would allow the firm to increase b_E, and this would enable the firm to induce greater efforts from experienced employees. In contrast, when the firm pays more than the necessary amount to prevent workers from quitting, decreasing $a_E(p_{t+1})$ from the optimal level derived in this section will lower the new employees' level of effort, which results in a decrease in profits. Thus, the firm does not have an incentive to deviate from the optimal solutions. Q.E.D.

The intuition for this result is that as long as the firm pays a positive amount of wages in the second period, it is more beneficial for the firm to pay wages such that these affect the efforts of new employees as well. Thus, the firm pays more than necessary to keep workers during the second period.

Proposition 2 *Experienced employees' bonuses move proportionally to the output price regardless of the possibility of performance-based layoffs.*

Proof of Proposition 2

From the first-order conditions for b_E, we obtain $p_{t+1} = 2e^*_E$. From Eq.(7), we also know that $2e^*_E = b^*_E(p_{t+1})$. Combining these two equations yields:

$$b^*_E(p_{t+1}) = p_{t+1} \quad \forall\, p_{t+1} \tag{19}$$

Q.E.D.

Eq.(19) implies that the piece rate for experienced workers is set equal to the output price. Thus, in equilibrium, the marginal revenue of effort from the viewpoint of a firm (p_{t+1}), the marginal disutility of effort ($2e^*_E$), and the marginal cost of effort from the viewpoint of a firm ($b^*_E(p_{t+1})$) are set to be equal. Eq.(19) also implies that firms base wages less on workers' performance during recessions. This is because during recessions, firms are discouraged from maintaining workers' incentives at a high level due to the low value of productivity.

Proposition 3 *Performance-based layoffs occur when $p^2_{t+1}/4 - U + C < 0$ is satisfied. This implies that performance-based layoffs are more likely to occur when layoff costs, C, and the output price, p_{t+1}, are low.*

Proof of Proposition 3

Substituting Eq.(15), Eq.(16), $2e^*_E = b^*_E(p_{t+1})$, and Eq.(19) into Eq.(14), we get the following:

$$\frac{\partial \mathcal{L}}{\partial \gamma_{t+1}} = \delta \left(\frac{e_N}{\bar{e}} - 1 \right) \left(\frac{1}{4} p_{t+1}^2 - U + C \right) g(p_{t+1}) + \mu_1(p_{t+1}) - \mu_2(p_{t+1}) = 0 \qquad \forall \, p_{t+1} \tag{20}$$

Since $(e_N/\bar{e} - 1)$ in the first term in Eq.(20) is always negative by assumption, the sign of $\{\mu_1(p_{t+1}) - \mu_2(p_{t+1})\}$ depends on the sign of $p_{t+1}^2/4 - U + C$, and can be categorized as:

$$\mu_1(p_{t+1}) - \mu_2(p_{t+1}) \begin{cases} < 0 \;\; if \;\; \frac{1}{4} p_{t+1}^2 - U + C < 0 \\ = 0 \;\; if \;\; \frac{1}{4} p_{t+1}^2 - U + C = 0 \\ > 0 \;\; if \;\; \frac{1}{4} p_{t+1}^2 - U + C > 0 \end{cases} \tag{21}$$

Note that these two multipliers cannot be positive at the same time since $\gamma_{t+1}(p_{t+1}) = 0$ and $\gamma_{t+1}(p_{t+1}) = 1$ cannot hold at the same time. Since both $\mu_1(p_{t+1})$ and $\mu_2(p_{t+1})$ are always non-negative, the sign of $\{\mu_1(p_{t+1}) - \mu_2(p_{t+1})\}$ can be negative only when $\mu_1(p_{t+1}) = 0$ and $\mu_2(p_{t+1}) > 0$. This corresponds to the case of $\gamma_{t+1}^*(p_{t+1}) = 1$, that is, the case in which the layoff decision is completely performance-based.

The second case, $\{\mu_1(p_{t+1}) - \mu_2(p_{t+1})\} = 0$, can be true only when $\mu_1(p_{t+1}) = \mu_2(p_{t+1}) = 0$ holds. In this case, $\gamma_{t+1}^*(p_{t+1})$ can take any number between 0 and 1 when p_{t+1} satisfies the condition, $p_{t+1}^2/4 - U + C = 0$, as an equality. With continuous p_{t+1}, this happens with zero probability. The last case, $\{\mu_1(p_{t+1}) - \mu_2(p_{t+1})\} > 0$, can be satisfied only when $\mu_1(p_{t+1}) > 0$ and $\mu_2(p_{t+1}) = 0$, which corresponds to the case of $\gamma^*(p_{t+1}) = 0$, that is, the case in which a firm's layoff decision is completely seniority-based. Mathematically, the optimal layoff decision stated above can be written as:

$$\gamma_{t+1}^*(p_{t+1}) \begin{cases} = 1 & if \;\; \frac{1}{4} p_{t+1}^2 - U + C < 0 \\ \in [0, 1] & if \;\; \frac{1}{4} p_{t+1}^2 - U + C = 0 \\ = 0 & if \;\; \frac{1}{4} p_{t+1}^2 - U + C > 0 \end{cases} \tag{22}$$

Thus the case of $\gamma^*_{t+1}(p_{t+1}) = 1$ is more likely to occur when p and C are low, and U is high. Q.E.D.

In words, the firm's optimal layoff decision can be explained as follows: when $p_{t+1} > 2\sqrt{U-C}$ is satisfied, $\gamma^*_{t+1}(p_{t+1}) = 0$ holds, that is, the optimal layoff rule is completely seniority-based, and no experienced employees will be laid off. When $p_{t+1} < 2\sqrt{U-C}$ is satisfied, the layoff decision is completely performance-based, and an experienced worker will be laid off with probability $1 - e_{\mathrm{N}}/\overline{e}$.

The next proposition explains how the optimal regular is related to the layoff decision stated in Proposition 3.

Proposition 4 In periods in which performance-based layoffs occur, the regular pay of experienced employees has a higher lower-bound than the regular pay in periods in which performance-based layoffs do not occur.

Proof of Proposition 4

If we substitute Eq.(19) and $e^*_E = p_{t+1}/2$ into Eq.(18), Eq.(18) becomes:

$$a_E(p_{t+1}) > U - \frac{1}{4}p^2_{t+1} \tag{23}$$

We know from Eq.(22) that $U - p^2_{t+1}/4 > C$ holds when $\gamma^*(p_{t+1}) = 1$, and thus, we can derive the following condition:

$$a_E(p_{t+1}) > C \quad \forall p_{t+1} \;\; s.t. \; p_{t+1} < 2\sqrt{U-C} \tag{24}$$

Thus, the lower bound of C exists for the regular pay in period $t+1$ when the output price of the second period is low enough for layoffs to occur.

In contrast, for p_{t+1} that satisfies $p_{t+1} > 2\sqrt{U-C}$, $a_E(p_{t+1})$ can be lower than C because the right-hand side of Eq.(23) is lower than C from Eq.(22). Q.E.D.

The intuition for this result is that as confirmed in Proposition 1, if the firm must pay wages in the second period anyway, it is more beneficial for the firm to pay wages such that these affect the efforts of new employees as well. Thus, the firm pays more than necessary to keep workers during the second period, paying high regular pay for periods in which layoffs occur and high bonuses for periods in which layoffs do not occur due to the high value of productivity.

Proposition 4 offers an implication for wage rigidity. Future wages scheduled to be paid in the next period during which layoffs do not occur do not affect new employees' current efforts, because workers will necessarily receive the wages without being laid off in the next period, regardless of their current effort levels. Thus, the firm cannot control new employees' efforts by their future wages scheduled to be paid in booms which results in a lower, or at least a less downwardly rigid, regular pay during booms.

In contrast, future wages scheduled to be paid in the next period during which layoffs occur, affect new employees' current efforts since workers will receive the wages only when they work hard in the current period, and avoid being laid off. Thus, the higher the wages scheduled to be paid in regressions are, the harder the workers will work. This gives the firm an incentive to pay high regular pay in periods during which layoffs occur. As a result, the regular pay of experienced workers has a lower bound, equal to the layoff costs when the output price is low enough that layoffs occur, while the regular pay can be below the layoff costs when the output price is high enough that layoffs do not occur. In this way, in this model, the downward wage rigidity during recessions occurs through a channel in which a low output price increases the probability of performance-based layoffs.

Proposition 5

Except for cases in which the output price greatly declines from period t to period $t+1$, workers' pay becomes more performance-based as their careers progress.

Proof of Proposition 5

Given Eq.(15) and Eq.(19), Eq.(16) can be rewritten as:

$$\frac{\partial V^E}{\partial e_N} + p_t - b_N + \delta \int_p \left(\gamma(p) \frac{1}{\overline{e}} \left(-a_E(p) + C \right) \right) dG(p) = 0 \tag{25}$$

As shown in Eq.(22), $\gamma^*_{t+1}(p_{t+1}) = 1$ holds for any p_{t+1} that satisfies $p_{t+1} < 2\sqrt{U(p_{t+1}) - C}$, and $\gamma^*_{t+1}(p_{t+1}) = 0$ holds for any p_{t+1} that satisfies $p_{t+1} > 2\sqrt{U(p_{t+1}) - C}$. Therefore, the inside of the integral in Eq.(25) becomes zero for the realizations of $p_{t+1} > 2\sqrt{U(p_{t+1}) - C}$, and the second term in Eq.(25) remains only for the case in which $p_{t+1} < 2\sqrt{U(p_{t+1}) - C}$:

$$p_t - b_N + \delta \int_{p<2\sqrt{U(p)-C}} \left(\frac{1}{\overline{e}} \left(-a_E(p) + C \right) \right) dG(p) = 0 \tag{26}$$

Then, the conditional mean of the regular pay in period $t+1$, conditional on $p_{t+1} < 2\sqrt{U(p_{t+1}) - C}$, is expressed as:

$$E[a^*_{E,t+1}(p)/p < 2\sqrt{U(p) - C}] = \frac{\overline{e}}{\delta} \left(p_t - b^*_N \right) \frac{1}{Pr\left(p < 2\sqrt{U(p) - C} \right)} + C \tag{27}$$

The first term in Eq.(27) shows that in order to maintain new employees' efforts, the lower the new employees' piece rate is, the higher the experienced employees' regular pay should be. From Eq.(24), we know that a_E for the realizations of p_{t+1} that satisfies $p_{t+1} < 2\sqrt{U(p_{t+1}) - C}$, is set greater than C, and thus its conditional mean should also be greater than C. Thus, the first term in Eq.(27) should be positive, which yields the following inequality:

$$p_t > b^*_N. \tag{28}$$

Q.E.D.

Proposition 5 implies that it is more important for the firm to raise experienced employees' piece rate than to raise new employees' piece rate since the former can affect not only experienced employees' current efforts but also new employees' efforts in the preceding period. As a result, the piece rate paid to new employees is set below the output price, while the piece rate paid to experienced employees is set equal to the output price. Thus, if workers encounter the same output price between periods t and $t+1$, they necessarily experience an increase in the piece rate as their careers progress. Except for the case in which the output price greatly declines from period t to period $t+1$, workers experience a piece rate increase as their careers progress[10]

3 Empirical Model

This section presents a strategy to empirically test the implications of the theoretical model. There are two steps in the evaluation of the theoretical model. The first step is layoff regression, which tests the implications of Proposition 3. The second step is wage regression, which tests the implications of Propositions 2 and 4.

3.1 Layoff Regression

Proposition 3 states that layoffs occur when inequality $p_{t+1}^2/4 - U(p_{t+1}) + C < 0$ is satisfied. This implies that layoffs are more likely to occur when the performance-based layoff costs, C, and the output price, p, are low.[11]

Thus, the following model is estimated:

$$Involuntary\,Leave_{it} = \gamma_0 + \gamma_1 NonUnion_{it} + \gamma_2\,Price_{it} + X_{it}\gamma + u_{it} \tag{29}$$

[10]Simple calculations using the first-order condition for b_N show that b_N would become equal to p_t if the possibility of performance-based layoffs were eliminated, that is, if $\gamma_{t+1}^*(p_{t+1}) = 0$ was satisfied with probability 1. If this were to happen, the firm would not have to differentiate b_N from b_E since both piece rates would affect only workers' current efforts without a possibility of layoffs. In this way, when there is no possibility of performance-based layoffs, the two periods become independent of each other, and then the two-period problem becomes a per-period profit-maximization problem.

[11]The impact of the output price on layoffs is actually indeterminate, because it depends on the functional form of $U(p_{t+1})$. However, as shown in Proposition 1, the negative relationship between the output price and the layoff probability is true as long as the functional form of $U(p_{t+1})$ is linear or concave, as is usually assumed in economics literature.

where $Involuntary\ Leave_{it}$ is an indicator function that equals to 1 if individual i was laid off or left his/her employer because of the firm's action in year t. $NonUnion$ is a dummy variable that is 1 if the individual is a non-union worker at the beginning of year t, and $Price_{it}$ represents the output price faced by the firm where individual i works at the beginning of year t. X_{it} represents the attributes of individual i and his/her firm at the beginning of year t.

The union status captures the magnitude of performance-based layoff costs, C, because these costs for unionized workers are expected to be higher than for non-union workers due to the contract provisions.[12]

According to Bewley (1999), 28% (86%) of non-union (unionized) workers are laid off according to inverse seniority, while 57% (7%) of non-union (unionized) workers are laid off according to performance. The model explains these widely observed layoff practices as follows. The costs associated with performance-based layoffs of unionized experienced employees are high enough that $p_{t+1}^2/4 - U(p_{t+1}) + C < 0$ is never satisfied for any p_{t+1}. Thus, the firm never lays off unionized experienced employees because of high layoff costs. In contrast, with the relatively low costs associated with laying off non-union workers, both $p_{t+1}^2/4 - U(p_{t+1}) + C > 0$ and $p_{t+1}^2/4 - U(p_{t+1}) + C < 0$ are possible. Then, the firm implements performance-based layoffs for non-union workers when the output price is low and no workers are laid off when the output price is high.

The expected sign for γ_1 is positive because non-union workers are expected to have a higher probability of being laid off than are unionized workers because of their lower layoff costs. The expected sign for γ_2 is negative.

In the layoff regression, it is expected that restricting the sample to experienced workers

[12] The survey conducted by Abraham and Medoff (1984) shows that in the U.S., approximately 78% of union groups were covered by written policies that specify seniority as the most important factor to be considered in permanent layoff decisions, while only 16% of non-union groups were covered by a similar policy. The Bureau of Labor Statistics (BLS) data also reveal that in 1970–71, over 70% of employee groups under major union agreements in the U.S. were covered by layoff provisions that specified seniority as the most important factor to be considered in permanent layoff decisions. Given this evidence, in the empirical analysis, I use union-status as a proxy for layoff costs, C.

places more focus on performance-based layoffs than on seniority-based layoffs. This is because the layoffs that happen among experienced or senior workers are less likely to be "seniority-based layoffs." Thus, Section 5 will present the results obtained from the sample that consists only of experienced workers. After confirming that the theoretical implication of Proposition 3 is true in the actual data, I will proceed to wage regressions to test Propositions 2 and 4.

3.2 Wage Regressions

First, a regular-pay regression is introduced to test Propositions 4, which states that the regular pay of experienced workers becomes downwardly rigid during periods in which performance-based layoffs occur Together with Proposition 3, which states that performance-based layoffs are likely to occur during recessions, Proposition 4 has implications for the downward rigidity of regular pay during a recession.

The theory predicts that wage rigidity is likely to arise in an environment where performance-based layoffs are likely to occur. Thus, in the regular-pay regression, I include the interaction term between the "non-union worker" dummy variable and the output price. By including this term, I can test whether wage rigidity is more likely to be observed for non-union workers whose layoffs are more likely to be based on performance.

In contrast, Proposition 2 predicts that the bonus depends solely on the output price, although the possibility of layoffs is indirectly related to the amount bonus through the output price. Hence, I will check whether the coefficient of the output price is significant and positive in the bonus-pay regression, because Proposition 2 suggests that the bonuses of experienced employees move proportionally to the output price. Thus, the estimated model is:

$$\begin{cases} lna_{it} = \alpha_0 + \alpha_1 NonUnion_{it} + \alpha_2 Price_{it} + \alpha_3 NonUnion_{it} \cdot Price_{it} + X_{it}\alpha + u_{it} \\ lnb_{it} = \beta_0 + \beta_1 NonUnion_{it} + \beta_2 Price_{it} + \beta_3 NonUnion_{it} \cdot Price_{it} + X_{it}\beta + e_{it} \end{cases} \quad (30)$$

where lna_{it} and lnb_{it} are the logarithms of regular pay and bonus pay for individual i in year t, respectively.

Proposition 4 expects α_3 to be significant and negative because regular pay is expected to fluctuate less in response to changes in the output price for non-union workers, who are more likely to face the downward wage rigidity. In contrast, the sign of β_2 implied by Proposition 2 is significant and positive.[13]

3.3 Restricting the Sample to Experienced Workers

The theoretical implications of wages could be true only for experienced workers, because the crux of the model is that under the threat of layoffs, firms maintain workers' incentives by using future wages, which will be paid to "experienced workers." Therefore, in Section 5, I will present the empirical results for both all workers and experienced workers only. In addition, I will confirm that the expected results on wages can be obtained or become more conspicuous when the sample is restricted to experienced workers.

In contrast, the theoretical implications of layoffs would be true for new employees as well when we relax the assumption that new employees are not laid off. However, as discussed in Section 3.1, restricting the sample to experienced workers in the layoff regression helps us focus more on performance-based layoffs rather than seniority-based layoffs. For this reason, I only report the results based on the sample comprising experienced workers.

[13] To use bonuses as the performance-based component of wages, it is necessary to ensure that bonuses are actually paid based on workers' current performance. This is supported by Freeman and Weitzman (1989), Ohashi (1989), and Brunello (1991), all of whom examined the Japanese bonus system. Freeman and Weitzman (1989) state that compensating workers for their effort is one of the main purposes of the bonus payment in Japan. Ohashi (1989) also found that bonuses are paid to compensate employees for the intensity of their work. Brunello (1991) found no statistically significant correlation between bonuses and employment level in the car, steel, and electric-machinery industries in Japan, which implies that the profit-sharing aspect of the Japanese bonus system is not substantial. In particular, since the 1990s, the importance of the "pay-for-performance" aspect of the Japanese bonus system has increased. Thus, an assumption of performance pay for Japan ($w(e) = a + be$) is more valid theoretically than that of fixed pay (w).

3.4 Sample Selection Bias

Since the dependent variables in the wage regressions, regular pay and bonuses, are reported only by working people, there might be a selection bias problem. If there is a tendency that workers with specific unobserved characteristics are likely to avoid layoffs during a recession, $Price_{it}$ and the error term might be correlated. For example, if workers with very high ability are less likely to be laid off during a recession, then a lower output price makes it more likely that workers included in the sample will be of high ability.[14] Since such unobservable individual characteristics might be included in the error term, $Price_{it}$ is thought to be correlated with the error term. Then, the coefficients α_2 and β_2 might be negatively biased in the OLS. Furthermore, it is thought that this selection bias is more serious for non-union workers, since their employment is thought to be less protected than that of unionized workers. This means that α_3 and β_3 might also be biased if we use OLS.

Thus, it is necessary to use the panel data to control for workers' fixed effects. In this study, I expect to resolve the problem by using the fixed effects model.

4 Data

This study uses Japanese panel data from the Keio Household Panel Survey (KHPS), conducted annually by Keio University. KHPS data are relatively new, as data collection for the survey began in 2004. This survey is conducted in January every year and includes observations randomly chosen from almost all regions and industries in Japan. A key feature of KHPS is that it is the first nationwide follow-up survey in Japan for individuals (4,000 households and 7,000 people) of all ages and both sexes that also captures information on education, employment, income, expenses, health, and family structure. The survey has been designed to enable comparisons with major international panel surveys, such as the Panel

[14] This type of selection bias is the so-called counter-cyclical composition bias, although the term is usually used in the context of aggregate time-series data (Stockman (1983), Bils (1985), Solon et al. (1994), and Chang (2000)).

Study of Income Dynamics (PSID) and European Community Household Panel (ECHP) survey.

The details of KHPS are as follows. Respondents for the first wave are men and women aged between 20 and 69, as of January 31, 2004, from across Japan. The first wave (2004) included 4,005 households; the second wave (2005) included 3,314 of the 4,005 households in the first wave; the third wave (2006), 2,887 households; and the fourth wave (2007), 2,643 households. The attrition rate from the first wave to the fourth wave is 34%. Although 1,419 new households were added to the samples in 2007, I do not use these households in this study.[15]

Industry-level CPIs are used as measures of the output price. Since KHPS records wage data from the previous year, the annual price indexes for the previous year are used as the independent variables in the wage regressions. Table 1 shows the changes in annual CPI for each industry during the period 2003–2006. CPI data are obtained from the Consumer Price Index data by the Statistics Bureau at the Ministry of Internal Affairs and Communications (Statistics Bureau, Ministry of Internal Affairs and Communications 2003-2006). To avoid a potential mismatch between the CPI data and the industry categories used in the survey, the service industry and the "financing and insurance" industry are excluded from the sample. In addition, because in many cases the outputs of the mining industries are used as intermediate goods traded between firms, the price index data in the Corporate Goods Price Index are used for the mining industry (Bank of Japan 2003-2006).

Table 2 contains descriptive statistics for the sample of layoff regression. Samples include only individuals who were working as of January in year t. Those represented in the first column are divided into two groups: those who left/changed their employer during the year t (shown in the second column) and those who continued with the same employer (shown in the third column). The layoff regression determines how the employment status and the output price at the beginning of year t affected the layoff probability during year t. Thus,

[15]The data can be extended in a future study, as this survey will continue.

Table 2 reports the characteristics of the workers (and employers) at the beginning of year t and the industry-level consumer price index during January. Because the survey asks about a change in employer during the previous year, information on a job change during year t can be obtained from the survey of year $t+1$. In contrast, the characteristics of the workers (and the employers) at the beginning of year t are obtained from the survey of year t. To utilize both, the sample is restricted to individuals who participated in the survey for at least two straight years.

The average age of the participants is 46.04 years and 63% of the sample did not belong to any labor union. Individuals who left or changed their previous employer during year t comprise 5% of the sample, and approximately 20% of these left involuntarily. This category includes layoffs, dismissals, and other firm-related reasons, excluding bankruptcy. The criterion, "Years Needed to be Experienced," represents the average value of the answer to the question: "*How long does it take for workers to feel they are experienced in your field?*," and the average value is calculated for each industry × occupation pair. The sample average of the answer to the question is 2.12 years. This measure is used to classify the sample into experienced workers and others.

Table 3 reports the descriptive statistics for the sample of wage regressions. In the wage regressions, observations are restricted to individuals who earned positive values of regular pay and bonuses.[16] In the estimation sample, the average monthly regular pay from 2003–2006 is JPY 327,301 (≈USD 3,273.01), while the average annual bonus for individuals who received a positive bonus amount is JPY 960,475 yen (≈USD 9,604.75). These amounts become higher if we restrict the sample to experienced workers. To distinguish "experienced" worker groups from other workers, two criteria are used: tenure of three years and "Years Needed to be Experienced." According to the general survey on working conditions conducted in 2003, three years of tenure is the most common minimum length of tenure that

[16] The reason why the layoff regression has more observations than the wage regressions is that only 60% of workers in the sample receive bonuses greater than zero. The samples are unified between the regular-pay and bonus-pay regressions, and accordingly, and thus the sample size for the regular-pay regression is also reduced.

is necessary for an employee to receive retirement allowances in Japan (Ministry of Health, Labor, and Welfare, Government of Japan 2003).[17] Thus, three years can serve as a useful threshold for classifying workers into "new" and "experienced" groups, because it becomes harder for a firm to lay workers off at a tenure of three years, at least in terms of costs.

The total annual bonus payment amounts to three times the employee's regular monthly pay. From this data, it can be confirmed that most employed workers in performance-pay jobs in Japan receive a substantial portion of their pay in the form of bonuses. This is consistent with the findings of previous studies that use other earning data.[18] Together with the fact that the amount paid as a bonus generally fluctuates, depending on the firm's and the worker's performance, this result implies an importance to assume performance-based pay rather than fixed wages, particularly for countries such as Japan.

5 Empirical Results

5.1 Layoff Regression Results

Table 4 presents the regression results of the layoff equation. The dependent variable is an indicator function that is 1 if the individual was laid-off or left his/her employer for firm-related reasons during year t. Individuals who were working at the beginning of year t are used for the sample. In this regression, layoff experience during year t is regressed on the industrial-level CPI during January, the non-union status dummy variable, and other worker characteristics at the beginning of the year. The other worker characteristics include

[17]The minimum tenure required for an employee to receive retirement allowances differs between those laid off and those who quit. For layoffs, the minimum tenure required to receive a retirement allowance is less than 1 year for 12.2%, 1–2.9 years for 30.3%, 2–2.9 years for 11.1%, 3–3.9 years for 38.7%, 4–4.9 years for 1.1%, and more than 5 years for 6.2% of all firms. For instances of quitting, I omit the overall distribution of firms over the criteria, but the fraction of firms that set the minimum requirement of tenure in the 3–3.9 years category is 60%.

[18]It is well known that the ratio of bonuses to total pay is traditionally higher in Japan than in other countries. Nakamura and Hubler (1998) show that the ratios of bonuses to regular pay in the 1980s were 0.317, 0.121, and 0.194 for Japan, Germany, and the U.S., respectively. According to Nakamura and Nakamura (1991), most employed workers in Japan are paid 25–33% of their total earnings in the form of bonus payments.

the male dummy variable, the education dummy variables, potential experience in years (=age−6−education years) and its square, tenure and its square, the marital status dummy variable, the number of children, the logarithm of the firm size, year dummy variables, payment-type dummy variables, and industry dummy variables.

The estimates in Table 4 show that the effect of CPI on layoff experience is significant and negative in all columns. In other words, the data show that layoffs are more likely to occur during periods in which the output price is low, which is consistent with Propositions 3. This is also consistent with the findings of Bewley (1999), who shows that the majority of layoffs are implemented in response to reduced demand for labor because of a decline in product demand.

Columns 3 to 6 show the results of the layoff regression among experienced workers only. As discussed in Section 3, it is expected that the layoffs that occurred among experienced workers are likely to be performance-based. The estimates from these columns suggest the significant and positive effect of the non-union worker dummy on layoff experience. This is consistent with the prediction from Proposition 3, which states that performance-based layoffs are more likely to occur when the costs of performance-based layoffs are low. Thus, it is expected that the theoretical predictions concerning performance-based layoffs are true in the actual data.

5.2 Wage Regression Results

In the wage regressions, I use the same explanatory variables as in the layoff regression, with two exceptions. First, I include the interaction between non-union status and industrial-level CPI in the wage regressions. Second, the CPI used in the wage regressions is the annual CPI (by industry) rather than the CPI during January.

Although the theoretical implication with regard to the output prices refers to the firm-specific output price, wages are often indexed in terms of the overall price level as well, either formally or informally. To capture this widely observed practice, the year dummy variables are also included in the explanatory variables.

Table 5 reports the results of the regular pay regression. As discussed in Section 3.4, the OLS estimates might suffer from a sample selection bias. Thus, the FE estimates, and not the OLS estimates, should be taken as the more reliable results. The FE estimates indicate that the coefficient of the interaction term is significant and negative, which supports Proposition 4. In other words, the regular pay of experienced employees is less responsive to changes in the output price for non-union workers, whose layoffs are more likely to be based on performance. Together with the result from the layoff regression, which states that performance-based layoffs are likely to occur during a recession, we get that downward wage rigidity occurs during recessions in the presence of performance-based layoffs.

Table 6 presents the results of the bonus-pay regression. Although the OLS estimates suggest insignificant coefficients for CPI, we confirmed in Section 3.4 that the CPI coefficient could be negatively biased in the OLS regression because of the sample selection problem. Indeed, if we examine the FE estimates, the effect of CPI on bonuses becomes significant and positive for experienced workers. Thus, the results of the bonus regression are consistent with Proposition 2: *the bonuses of experienced employees move in proportion to the output price.*

These results from the wage regressions are consistent with Freeman and Weitzman (1989), who found that Japanese bonuses are far more procyclical than Japanese base wages.[19]

[19] Freeman and Weitzman (1989) also found that base wages in Japan are negatively related to employment. The results obtained from Table 5 are also consistent with this finding, because in my study, base wages become downwardly rigid when employment shrinks as a result of layoffs. Consequently, this implies a negative relationship between base wages and employment. Moreover, Freeman and Weitzman (1989) found that bonuses are positively related to employment. Note that, in my study, I assume that bonuses are paid according to workers' levels of effort. As a result, they are set equal to the output price. Thus, although the model assumes the pay-for-performance bonus model, the results do not refute the positive correlation between the amount paid in bonuses and the firms' profits (or other variables that reflect the firms' profits, such as employment). Therefore, the findings here do not contradict those of Freeman and Weitzman (1989), which also analyzed the Japanese labor market.

6 Conclusion

This study provides a theoretical and empirical analysis of the effect of performance-based layoffs on wage rigidity in the context of performance pay. Given the findings of Bewley (1999) that performance-based layoffs frequently occur during a recession, especially for non-union workers, I constructed a theoretical model in which firms' layoff decisions depend on worker performance, and firms can decide how much weight to place on performance in the layoff decision. Thus, both the rules for layoffs and wages are endogenous in my model.

The main results obtained from the theoretical model are as follows: *(a) Performance-based layoffs are more likely to occur when the layoff costs and the output price are low. (b) Experienced employees' regular pay is likely to be downwardly rigid during periods in which performance-based layoffs occur. (c) Bonuses move proportionally to the output price.*

The reason for result (b) is important. Without the threat of layoffs, wages scheduled to be paid in the next period do not affect workers' current levels of effort because they will necessarily receive their wages without being laid off in the next period, regardless of their current effort level. Thus, the firm cannot control new employees' levels of effort using future wages, which results in lower, or at least less, downwardly rigid regular pay. In contrast, under the threat of layoffs, workers can receive the next period's wages only when they work hard in the current period and avoid layoffs in the next. Thus, the promise of higher wages in the next period means workers try harder to avoid being laid off, and so invest greater effort in their work. This gives the firm an incentive to raise the future regular pay to maintain workers' current levels of effort, which results in downwardly rigid regular pay for experienced employees, under the threat of layoffs.

The explanation underlying (c) is as follows. The lower value of productivity during a recession discourages firms from maintaining workers' current incentives at a higher level. This results in a bonus that moves in proportion to the output price.

The empirical analysis in this paper uses Japanese panel data from the Keio Household Panel Survey (KHPS). All empirical results confirmed the theoretical implications:

performance-based layoffs are likely to occur for non-union workers and during a recession, and regular pay is likely to be downwardly rigid for non-union workers whose layoffs are more likely to be based on performance. Given that performance-based layoffs are likely to occur during a recession, the result concerning regular pay implies that downward wage rigidity occurs in such a situation. Furthermore, the bonus-pay regression confirmed that firms base their wages less on workers' performance during a recession by paying lower bonuses. As a result, wages during a recession become both "downwardly rigid" and "rigid" (inflexible) with respect to performance.

This explanation for wage rigidity is applicable particularly for non-union workers whose layoff decisions are likely to be performance-based and for countries such as Japan, where performance-based pay has been widely employed.

References

Abraham, K. G., Medoff, J. L., 1984. Length of service and layoffs in union and nonunion work groups. Industrial and Labor Relation Review 38 (1), 87–97.

Baily, M. N., 1977. On the theory of layoffs and unemployment. Econometrica 45 (5), 1043–1063.

Bank of Japan, 2003-2006. Corporate goods price index: Long-term time-series data. Bank of Japan.

Bewley, T. F., 1999. Why Wages Do Not Fall During a Recession. Harvard University Press.

Bils, M. J., 1985. Real wages over the business cycles: Evidence from panel data. Journal of Political Economy 93 (4), 666–689.

Brunello, G., 1991. Bonuses, wages and performance in Japan: Evidence from micro data. Ricerche Economiche 45, 377–395.

Chang, Y., 2000. Wages, business cycles, and comparative advantage. Journal of Monetary Economics 46 (1), 143–171.

Freeman, R. B., Weitzman, M. L., 1989. Bonuses and employment in Japan. NBER Working Paper (1878).

Gibbons, R., Katz, L. F., 1991. Layoffs and lemons. Journal of Labor Economics 9 (4), 351–380.

Grossman, G. M., 1983. Union wages, temporary layoffs, and seniority. American Economic Review 73 (3), 277–290.

Ioannides, Y. M., Pissarides, C. A., 1983. Wages and employment with firm-specific seniority. Bell Journal of Economics. 14 (2), 573–580.

Laing, D., 1994. Involuntary layoffs in a model with asymmetric information concerning worker ability. Review of Economic Studies 61 (2), 375–392.

Lemieux, T., Macleod, W. B., Paren, D., 2009. Performance pay and wage inequality. Quarterly Journal of Economics 124 (1), 1–49.

Macleod, W. B., Malcomson, J. M., Gomme, P., 1994. Labor turnover and the natural rate of unemployment: Efficiency wage vs frictional unemployment. Journal of Labor Economics 12 (2), 276–315.

Ministry of Health, Labor, and Welfare, Government of Japan, 2003. General survey on working conditions 2003. In Japanese.

Nakamura, M., Hubler, O., 1998. The bonus share of flexible pay in Germany, Japan and the US: Some empirical regularities. Japan and the World Economy 10 (2), 221–232.

Nakamura, M., Nakamura, A., 1991. Risk behavior and the determinants of bonus versus regular pay in Japan. Journal of the Japanese and International Economies 5 (2), 140–159.

Nosal, E., 1990. Incomplete insurance contracts and seniority layoff rules. Economica 57 (228), 423–438.

Ohashi, I., 1989. On the determinants of bonuses and basic wages in large Japanese firms. Journal of the Japanese and International Economies 3 (4), 451–479.

Reagan, P. B., 1992. On-the-job training, layoff by inverse seniority, and the. incidence of unemployment. Journal of Economics and Business 44 (4), 317–324.

Shapiro, C., Stiglitz, J. E., 1984. Equilibrium unemployment as a worker discipline device. American Economic Review 74 (2), 433–444.

Solon, G., Barsky, R., Parker, J. A., 1994. Measuring the cyclicality of real wages: How important is compositional bias? Quarterly Journal of Economics 109 (1), 587–616.

Sparks, R., 1986. A model of involuntary unemployment and wage rigidity: Worker incentives and the threat of dismissal. Journal of Labor Economics 4 (4), 560–581.

Statistics Bureau, Ministry of Internal Affairs and Communications, 2003-2006. Annual report on the consumer price index. Statistics Bureau, Ministry of Internal Affairs and Communications.

Stockman, A. C., 1983. Aggregation bias and the cyclical behavior of real wages. mimeo, University of Rochester.

Strand, J., 1991. Unemployment and wages under worker moral hazard with firm-specific cycles. International Economic Review 32 (2), 601–612.

Strand, J., 1992. Business cycles with worker moral hazard. European Economic Review 36 (6), 1291–1303.

Table 1: Changes in CPI by Industry

Industry \ Year	2003	2004	2005	2006
Agriculture	99.6	103.2	100.0	102.0
Communications	108.6	107.3	100.0	96.4
Construction	100.6	100.3	100.0	100.3
Electricity, Gas, Heat Supply, and Water	99.1	99.2	100.0	103.6
Fishery and Forestry	99.6	103.2	100.0	102.0
Manufacturing	100.2	100.3	100.0	100.6
Mining	99.5	99.6	100.0	101.0
Real Estate	100.3	100.1	100.0	100.0
Transport	100.0	100.0	100.0	99.6
Wholesale and Retail Trade	100.2	100.3	100.0	100.6

Note: The base year for CPI is 2005, and the CPI for 2005 is fixed at 100 for each industry. The CPI data is obtained from the Consumer Price Index data by the Statistics Bureau at the Ministry of Internal Affairs and Communications (Statistics Bureau, Ministry of Internal Affairs and Communications 2003-2006). To avoid a potential mismatch between the CPI data and the industry categories used in the survey, the service industry and the "financing and insurance" industry are excluded from the sample. The price index for the mining industry is obtained from the price index data in the Corporate Goods Price Index (Bank of Japan 2003-2006).

Table 2: Descriptive Statistics for the Estimation Sample of Layoff Regression

	All	Left Employer during Year t	No Change in Employer
CPI by industry	100.18	100.09	100.18
	(0.96)	(0.89)	(0.96)
Age	46.04	41.70	46.26
	(11.53)	(11.83)	(11.47)
Tenure	13.82	6.14	14.20
	(11.81)	(8.90)	(11.81)
Number of Children	1.49	1.41	1.49
	(1.09)	(1.14)	(1.09)
Years Needed to be Experienced	2.12	1.98	2.13
	(1.19)	(1.00)	(1.20)
Firm Size	202.42	166.88	204.16
	(206.62)	(185.12)	(207.48)
Male	0.69	0.59	0.70
Married	0.85	0.75	0.86
Non-union Worker	0.63	0.79	0.62
Change/Left Employer during Year t	0.05	1.00	0.00
Involuntary Leave	0.01	0.17	0.00
Education Dummy Variables			
Junior High School	0.10	0.06	0.10
High School	0.53	0.58	0.53
Junior College	0.10	0.12	0.10
University	0.25	0.22	0.25
Graduate School	0.01	0.01	0.01
Payment-Type Dummy Variables			
Paid Monthly	0.73	0.57	0.74
Paid Weekly	0.00	0.00	0.00
Paid Daily	0.07	0.08	0.07
Paid Hourly	0.15	0.29	0.14
Paid Yearly	0.05	0.06	0.05
Observations	4638	217	4421

Note: Column 1 contains the descriptive statistics for individuals who were working as of January in year t. Those represented in Column 1 are divided into two groups: those who left/changed their employer during year t (Column 2) and those who continued with the same employer (Column 3). "Involuntary Leave" is a dummy variable that is 1 if the individual was laid off or left his/her employer due to some reason on the firm's side during year t. CPI is the industry-level consumer price index during January of each year. The CPI for January 2005 is fixed at 100 for each industry. "Years Needed to be Experienced" represents the average length of years it takes for workers to feel they are experienced in their field, and the average value is calculated for each industry $\times$ occupation pair. To avoid a potential mismatch between CPI data and the industry categories used in the survey, the service industry and the "financing and insurance" industry are excluded from the sample.

Table 3: Descriptive Statistics for the Estimation Sample of Wage Regression

	All Workers	Experienced Workers	
		Tenure> X Years	Tenure>Three Years
Regular Pay (100 yen≈ 1 USD / month)	3273.01	3348.66	3442.42
	(1776.72)	(1788.03)	(1802.16)
Bonus (100 yen≈ 1 USD / year)	9604.75	10068.96	10514.09
	(9277.52)	(9413.45)	(9525.70)
CPI by industry	100.45	100.43	100.44
	(1.51)	(1.44)	(1.47)
Age	45.03	45.61	45.98
	(10.68)	(10.46)	(10.29)
Tenure	15.13	16.60	17.49
	(11.28)	(10.86)	(10.55)
Number of Children	1.49	1.52	1.55
	(1.06)	(1.05)	(1.05)
Years Needed to be Experienced (X)	2.19	2.15	2.24
	(1.21)	(1.20)	(1.23)
Firm Size	273.13	277.86	281.22
	(204.70)	(204.06)	(204.33)
Male	0.77	0.78	0.80
Married	0.86	0.88	0.89
Non-union Worker	0.62	0.61	0.60
Education Dummy Variables			
Junior High School	0.07	0.07	0.07
High School	0.53	0.53	0.52
Junior College	0.10	0.10	0.10
University	0.28	0.28	0.29
Graduate School	0.02	0.02	0.02
Payment-Type Dummy Variables			
Paid Monthly	0.86	0.87	0.88
Paid Weekly	0.00	0.00	0.00
Paid Daily	0.04	0.04	0.04
Paid Hourly	0.08	0.07	0.06
Paid Yearly	0.02	0.02	0.02
Observations	3748	3389	3194

Note: Observations are restricted to those who earned positive values of regular pay and bonuses. For "experienced" worker groups, two criteria are used: those whose length of tenure is longer than X years and those whose tenure is longer than three years, where X represents the average length of years it takes for workers to feel they are experienced in their field (by industry). CPI is the annual industry-level consumer price index in Table 1.A.

Table 4: Layoff Regression (Probit)

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable:	All Workers		Experienced Workers			
Involuntary Leave=1			Tenure> X Years		Tenure>Three Years	
CPI	-0.0052	-0.0055	-0.0046	-0.0043	-0.0037	-0.0030
	(0.0014)	(0.0012)	(0.0020)	(0.0017)	(0.0018)	(0.0016)
Non-union Worker	0.0011	0.0011	0.0015	0.0015	0.0019	0.0019
	(0.0009)	(0.0009)	(0.0007)	(0.0007)	(0.0006)	(0.0006)
Male	0.0003	0.0003	0.00002	0.00002	0.0003	0.0003
	(0.0023)	(0.0023)	(0.0015)	(0.0016)	(0.0016)	(0.0016)
High School	-0.0045	-0.0045	-0.0035	-0.0034	-0.0058	-0.0057
	(0.0012)	(0.0011)	(0.0015)	(0.0015)	(0.0020)	(0.0020)
Junior College	-0.0017	-0.0017	-0.0013	-0.0013	-0.0022	-0.0021
	(0.0009)	(0.0009)	(0.0007)	(0.0007)	(0.0006)	(0.0006)
University	-0.0020	-0.0020	-0.0011	-0.0011	-0.0025	-0.0025
	(0.0009)	(0.0009)	(0.0008)	(0.0008)	(0.0009)	(0.0009)
Graduate School	0.0041	0.0040	0.0109	0.0110	0.0015	0.0016
	(0.0097)	(0.0094)	(0.0157)	(0.0157)	(0.0056)	(0.0057)
Experience	0.0004	0.0004	0.0004	0.0004	0.0006	0.0006
	(0.0002)	(0.0002)	(0.0001)	(0.0001)	(0.0003)	(0.0003)
Experience^2/100	-0.0006	-0.0006	-0.0007	-0.0007	-0.0010	-0.0010
	(0.0003)	(0.0003)	(0.0002)	(0.0002)	(0.0004)	(0.0004)
Tenure	-0.0007	-0.0007	-0.0003	-0.0003	-0.0003	-0.0003
	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Tenure^2/100	0.0012	0.0012	0.0006	0.0006	0.0006	0.0006
	(0.0003)	(0.0003)	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Married	-0.0062	-0.0061	-0.0056	-0.0056	-0.0033	-0.0033
	(0.0039)	(0.0039)	(0.0044)	(0.0045)	(0.0047)	(0.0046)
Number of Children	0.0007	0.0007	0.0007	0.0006	0.0001	0.0001
	(0.0005)	(0.0005)	(0.0006)	(0.0006)	(0.0006)	(0.0006)
ln(Firm Size)	-0.0004	-0.0004	0.0001	0.0001	0.0002	0.0001
	(0.0003)	(0.0003)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Year Dummies	No	Yes	No	Yes	No	Yes
Payment-Type Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.1264	0.1267	0.1694	0.1697	0.1683	0.1707
Observations	4638	4638	3686	3686	3410	3410

Note: Marginal effects evaluated at the sample mean are reported. Standard errors, clustered at industry levels, are in parentheses under the regression coefficients. For "experienced" worker groups, two criteria are used: those whose length of tenure is longer than X years and those whose tenure is longer than three years, where X represents the average length of years it takes for workers to feel they are experienced in their field (by industry × occupation pair). The dependent variable is an indicator function that is 1 if the individual was laid off or left his/her employer due to some reason on the firm's side during year t. Individuals who were working at the beginning of year t are used for the sample. All explanatory variables represent information reported at the beginning of year t. The reference group for the education dummy variables is "Junior High School." CPI is the industry-level consumer price index during January of each year. The base year for CPI is 2005, and the CPI for January 2005 is fixed at 100 for each industry.

Table 5: Regular Pay Regression

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable:	All Workers		Experienced Workers			
ln (Regular Pay)			Tenure> X Years		Tenure>Three Years	
	OLS	FE	OLS	FE	OLS	FE
CPI	0.004	0.004	0.004	0.004	0.002	0.004
	(0.002)	(0.001)	(0.003)	(0.001)	(0.003)	(0.001)
Non-union Worker	0.448	0.676	0.430	0.496	0.162	0.585
	(0.408)	(0.208)	(0.436)	(0.140)	(0.432)	(0.118)
CPI·Non-union Worker	-0.004	-0.007	-0.004	-0.005	-0.001	-0.006
	(0.004)	(0.002)	(0.004)	(0.001)	(0.004)	(0.001)
Male	0.578	-	0.581	-	0.581	-
	(0.029)		(0.025)		(0.025)	
High School	0.032	-	0.025	-	0.041	-
	(0.022)		(0.024)		(0.023)	
Junior College	0.093	-	0.097	-	0.122	-
	(0.031)		(0.033)		(0.037)	
University	0.201	-	0.184	-	0.204	-
	(0.033)		(0.039)		(0.039)	
Graduate School	0.387	-	0.384		0.405	-
	(0.082)		(0.078)		(0.072)	
Experience	0.030	0.066	0.030	0.062	0.029	0.060
	(0.003)	(0.013)	(0.002)	(0.018)	(0.003)	(0.016)
$Experience^2/100$	-0.058	-0.062	-0.061	-0.054	-0.057	-0.051
	(0.008)	(0.014)	(0.006)	(0.024)	(0.005)	(0.021)
Tenure	0.018	0.012	0.019	-0.073	0.020	-0.070
	(0.003)	(0.007)	(0.003)	(0.175)	(0.004)	(0.174)
$Tenure^2/100$	-0.013	-0.035	-0.014	-0.058	-0.017	-0.090
	(0.005)	(0.023)	(0.007)	(0.046)	(0.007)	(0.036)
Married	-0.016	-0.024	-0.007	-0.029	-0.000	-0.031
	(0.030)	(0.024)	(0.030)	(0.021)	(0.026)	(0.022)
Number of Children	0.011	0.014	0.010	0.009	0.014	0.009
	(0.024)	(0.025)	(0.025)	(0.024)	(0.024)	(0.024)
ln(Firm Size)	0.035	0.017	0.033	0.020	0.033	0.027
	(0.006)	(0.007)	(0.005)	(0.009)	(0.005)	(0.018)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Payment-Type Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.641	0.055	0.640	0.054	0.624	0.058
Observations	3751	3751	3389	3389	3197	3197

Note: Standard errors, clustered at industry levels, are in parentheses under the regression coefficients. For "experienced" worker groups, two criteria are used: those whose length of tenure is longer than X years and those whose tenure is longer than three years, where X represents the average length of years it takes for workers to feel they are experienced in their field (by industry $\times$ occupation pair). The reference group for the education dummy variables is "Junior High School." CPI is the annual industry-level consumer price index in Table 1.

Table 6: Bonus Pay Regression

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable:	All Workers		Experienced Workers			
ln (Bonus Pay)			Tenure> X Years		Tenure>Three Years	
	OLS	FE	OLS	FE	OLS	FE
CPI	-0.005	-0.002	0.001	0.007	0.0002	0.006
	(0.007)	(0.003)	(0.007)	(0.003)	(0.007)	(0.003)
Non-union Worker	-3.281	-0.806	-1.879	-0.084	-1.693	-0.083
	(0.772)	(0.221)	(0.885)	(0.146)	(0.946)	(0.182)
CPI·Non-union Worker	0.032	0.008	0.018	0.0004	0.016	0.0004
	(0.008)	(0.002)	(0.009)	(0.001)	(0.009)	(0.002)
Male	0.712	-	0.700		0.720	
	(0.079)		(0.080)	-	(0.088)	-
High School	0.160	-	0.142		0.133	
	(0.038)		(0.041)	-	(0.049)	-
Junior College	0.260	-	0.268		0.265	
	(0.069)		(0.060)	-	(0.057)	-
University	0.458	-	0.426		0.416	
	(0.046)		(0.047)	-	(0.050)	-
Graduate School	0.773	-	0.726	-	0.751	-
	(0.172)		(0.176)		(0.167)	
Experience	0.017	0.086	0.017	0.104	0.025	0.118
	(0.010)	(0.011)	(0.010)	(0.011)	(0.014)	(0.012)
$Experience^2/100$	-0.057	-0.129	-0.062	-0.151	-0.073	-0.170
	(0.015)	(0.031)	(0.016)	(0.047)	(0.021)	(0.043)
Tenure	0.058	0.075	0.048	0.146	0.039	0.125
	(0.008)	(0.023)	(0.007)	(0.089)	(0.015)	(0.090)
$Tenure^2/100$	-0.065	-0.174	-0.037	0.107	-0.022	0.187
	(0.009)	(0.072)	(0.009)	(0.060)	(0.022)	(0.086)
Married	0.109	0.140	0.117	0.096	0.126	0.100
	(0.044)	(0.120)	(0.050)	(0.131)	(0.035)	(0.134)
Number of Children	-0.011	-0.025	-0.012	-0.009	-0.010	-0.013
	(0.038)	(0.043)	(0.041)	(0.045)	(0.042)	(0.046)
ln(Firm Size)	0.118	0.024	0.123	0.041	0.127	0.041
	(0.036)	(0.018)	(0.037)	(0.013)	(0.037)	(0.012)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Payment-Type Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.562	0.049	0.562	0.029	0.549	0.026
Observations	3751	3751	3389	3389	3197	3197

Note: Standard errors, clustered at industry levels, are in parentheses under the regression coefficients. For "experienced" worker groups, two criteria are used: those whose length of tenure is longer than X years and those whose tenure is longer than three years, where X represents the average length of years it takes for workers to feel they are experienced in their field (by industry $\times$ occupation pair). The reference group for the education dummy variables is "Junior High School." CPI is the annual industry-level consumer price index in Table 1.