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Unions, Job Security, and Incentives of Workers

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Abstract

We consider why blue collar workers are more likely to organize unions than white collar workers by looking at commitment devices and imperfect signals on workers' actions. Under contractual incompleteness, firms cannot *ex ante* promise to keep employment levels high. However, if unions resist firms' dismissal policies by the request of high severance pay, unions can play a significant role as a commitment device for job security. Then, since firms can decrease wage and increase employment level, the profit of unionized firms can be more than that of non-union firms. Furthermore, we show that imperfect signals on workers' actions weakens the role of unions as a commitment device. This results in less union organizing by white collar workers since the efforts level of white collar workers is more difficult to observe than that of blue collar workers.

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1. Introduction

Union membership rates in private sectors have been decreasing in many developed countries. One cause is the transition of the industrial structure. The share of the service industry in the employee population has been rapidly increasing for about four decades and has exceeded that of the manufacturing industry. With this change, white collar employees increase. On the other hand, unions are less likely to be organized, participated in, and managed by white collar employees compared to blue collar workers. Blanchflower and Freeman (1992) point out the difference of union membership rates between manual workers and non-manual workers in major developed countries: 30%-13% (U.S.), 53%-42% (U.K.), 44%-27% (Germany), and 56%-45% (Australia), where the former is the membership rate of manual workers and the latter is that of non-manual workers. Farber (1983), Edward *et al.* (1992), Jacobi, Keller, and Müller-Jentsch (1992), Hotz-Hart (1992), and Visser (1992) point out similar results. Our purpose here is to consider the reason why the union membership rate of white collar workers is lower than that of blue collar workers by focusing on the union's role as a commitment device and imperfect signals on workers' actions.

Recent studies consider commitment devices under incompleteness of contracts: the effect of issuing bonds for raising capital (Agihon and Bolton (1992) and Dewatripont and Tirole (1994)); delegation of authority (Cremer (1995), Agihon and Tirole (1997), and Itoh and Hayashida (1997)); decentralization or centralization economy (Dewatripont and Maskin (1995) and Qian and Xu (1998)); and, privatization of public firms (Schmidt (1996)). This paper provides a new view of unions as commitment devices.

A simple labor contract specifying basic wage level is considered. Usually, payment is explicitly described in labor contracts, i.e., wage offers are verifiable. Unless it is verifiable, many workers may not get paid if a firm is unwilling to pay the wage, and the firm is not punished in court because of unverifiability. Hence, as labor laws state, basic wage should be described explicitly in labor contracts. However, workers still face uncertainty in job security under the free dismissal principle supported by labor laws. A firm can dismiss employees under some restrictions determined by labor laws. Actually, labor laws prohibit workers and firms from making long-term contracts beyond one year in the U.S. and Japan. Furthermore, dismissal rates of employees contingent on the states cannot be described or determined *ex ante* in labor contracts due to bounded rationality or huge transaction costs. Under contractual incompleteness, a firm cannot *ex ante* promise to keep employment high nor promise not to maximize its *ex post* profit. In other words, opportunism cannot be constrained: a firm always maximizes the *ex post* profit.

Employees then take this into account when making contracts with a firm. When workers are required to make efforts at increasing the possibility of good states for a firm, the firm must compensate the cost of workers' efforts by paying a wage higher than that in the spot labor market. Since the firm optimizes its employment level *ex post* and does not maintain excess employment after observing the realized state, workers have no incentives for making contracts with the firm and putting forth efforts unless a sufficiently high wage is offered.

If the union's resistance activities to the firm yield sufficient severance pay as dismissal compensation to dismissed employees, then a low basic wage can cover workers' efforts cost, and a unionized firm will have a lower payment and higher job security than a non-union firm. Therefore, the unionized firm can use the union as a commitment device for job security, and increase the *ex ante* expected profit, although the firm loses *ex post* free controllability of employment level. As Eguchi (2000a) shows, under incompleteness of contracts, unions might be welcomed by firms because unions act as commitment devices.

Furthermore, we extend the model to the case of imperfect signals on workers' actions. Under the existence of imperfect signals, the above result can be modified, that is, high job security, which the union helps ensure, may discourage workers from making efforts. Uncertainty of employment enhances workers' incentives under contractual incompleteness. If workers were never dismissed as the result of making explicit and verifiable contracts, they would have no incentives for making efforts since shirking workers would not be punished by firm managers. Hence, if the signal is sufficiently imperfect, workers' motivations can be weakened by the existence of unions. We will provide a simple example and show that the imperfection of the signal lowers the value of unions as commitment devices. Firms are then unwilling to allow unions, and thus are likely to attack unions' activities and discourage employees from managing and participating in unions. Indeed, as Freeman and Rebick (1989) and Farber (1990) show, the acceptance of firm managers is very crucial to organizing unions. When firm managers are opposed to employees' organizing and managing unions, employees very often fail to organize and manage unions.

The above argument may explain why blue collar workers more often organize, manage, and participate in unions than white collar workers. Outputs of blue collar workers are more observable than those of white collar workers, and the outputs of white collar workers, except in the case of car and insurance sales, are not likely to be directly linked to a firm's output. For example, consider jobs of white collar workers in personnel departments, general affairs departments, public information sections, and accounting

sections. It is difficult for firm managers to distinguish whether employees have delivered efforts. Therefore, the signal is less perfect and precise at the workshop of white collar workers than of blue collar workers. Our model implies that firms are less willing to have white collar employees organize and manage unions.

This paper is organized in the following manner. In chapter 2 we present the model and compare profits and job security in firms with unions to those without unions. We will show that unions play a significant role as a commitment device, and, as such, the expected profit of firms with unions can be more than that of firms without unions. Chapter 3 focuses on the imperfect signal case. In this case, firms are unwilling to allow unions since their presence is likely to break the incentive scheme. In chapter 4, we discuss the characteristic differences and union membership rates between blue and white collar workers. Finally, our conclusions are set forth in chapter 5.

2. Basic Model

When a firm intends to dismiss workers, dismissed workers can get sufficient severance pay as dismissal compensation by the resistance activities of a union. As we mention later, after wage has been decided, both a union and a firm observe the state. In a recession, the firm attempts to dismiss some employees to maximize its profit and sweep out an excess of workers. On the other hand, the union can get severance pay as the firm's dismissal cost by its various activities, for example, strike activities, lockouts, accusations of 'unfair' dismissal in the mass media, demonstrations and sit-ins. Without a union, workers cannot sufficiently obtain severance pay on being dismissed by a firm due to no bargaining power.

Timing of decisions by a firm and a union is as follows. See figure 1.

① First, the firm has a skilled labor pool normalized to 1 and offers wage w to the skilled workers. The firm cannot make contracts contingent on the state with any worker and the union. This basic wage offer is verifiable.

② Workers are required to make efforts for increasing the possibility of good states for the firm. Efforts level is discrete: $e = \{\underline{e}, \bar{e}\}$. The efforts cost function is expressed by $C(\underline{e}) = 0$, $C(\bar{e}) = c$, where c is a constant. If a worker shirks, he is always discovered and dismissed by the firm at no cost.[1]

③ After workers' decision on making efforts, the firm can choose to continue the

[1] Workers' incentive problem is analyzed later.

industrial relation or not. If the firm deviates the industrial relation, the firm gets zero profit certainly and workers receive no payment since the production process in the firm has not stated at all. On the other hand, if the firm keeps employment, the firm and workers proceed to next step.

④ All workers pay for routine management costs of the union *K*.

⑤ Then, Nature chooses a state, and the firm and the union know the realized state $\theta \in (0, \bar{\theta}]$.

⑥ The union chooses a resistance strategy and the firm determines the employment level. Their strategies are the best response to each other on the equilibrium.

⑦ Dismissed workers receive dismissal compensation *R*. On the other hand, employees retained in the firm get the wage specifying in the original contract.

Workers' skills are firm specific and essential to producing outputs, and thus the firm cannot employ any worker from the outside labor market *ex post*. The firm can use labor inputs normalized to 1 at most.

The union determines the per capita severance pay *R* which is paid to a dismissed worker. If the firm dismisses (1-*L*) workers, the total severance pay as firing costs is *R*(1-*L*), where *L* is the actual employment level of the firm. The firm's profit $\pi(\theta)$, given θ, is expressed as follows:

$$\pi(\theta) = \theta f(L) - wL - R(1-L) \qquad s.t. \quad L \leq 1$$

It is assumed that the production function *f*(*L*) satisfies the following condition: $f' > 0,\ f'' < 0,\ f(0) = 0$ and $\lim_{L \to 0} f'(L) = +\infty$. This assumption implies that, if *R*=0, a positive employment level *L*, which yields a positive profit to the firm, always exists under any state $\theta \in (0, \bar{\theta}]$.

Throughout this paper, the group working of the skilled workers is absolutely necessary. If cooperation of the employees is not realized, the firm's state will not be enhanced. If a worker shirks, the firm is likely to incur a bad state. Thus, the firm's expected profit will be less than zero:

$$E(\pi(\theta)|\underline{e}) < 0 < E(\pi(\theta)|\bar{e}). \qquad ...(1)$$

The left hand implies the expected profit when some workers shirk, and the right hand is that when all workers make efforts. Hence, when the firm discovers shirking workers, the firm is willing to choose not to continue the industrial relation and zero profit is realized.

It is assumed that, in the unionized firm, all workers belong to the union. Although workers sufficiently exercise their bargaining power to get severance pay if a

union is organized, it is costly for workers to manage the union and obtain the dismissal compensation. The activity cost of a worker is expressed by $C_U = \frac{R^2}{2} + K$, K is a fixed cost of union management. The fixed cost K implies a union membership fee and is devoted to routine management of the union. The quardratic term $\frac{R^2}{2}$ is the variable cost of the union activity to obtain the severance pay R. The more severance pay workers will get, the more rapidly the activity cost increases. The expenditure of C_U by workers is socially wasteful.

Union case

We consider the stage after the state is revealed from a view of backward induction consideration. At this stage, a basic wage is given. First, consider the firm's best response to the union's resistance strategy. Given R, an optimal employment strategy is determined as follows:

$$L_U = \min\left\{1, (f')^{-1}\left(\frac{w_U - R}{\theta}\right)\right\}, \qquad ...(2)$$

where L_U or w_U is employment level or wage with the union, respectively. This equation is the first order condition. When the union's resistance level is large, the firm attempts to employ more workers.

Next, consider the union's optimal resistance strategy. The expected utility of workers with the union, in which the fixed cost as a union membership fee and effort costs have been sunk, is $w_U L_U + R(1 - L_U) - \frac{R^2}{2}$. Given the firm's positive employment strategy L_U, an optimal strategy which maximizes the expected utility of workers is represented by

$$R = 1 - L_U. \qquad ...(3)$$

A unique Nash equilibrium is introduced from (2) and (3). In figure 2, the Nash equilibrium is expressed by $A: (L_U^*, 1 - L_U^*)$, where L_U^* satisfies

$$\theta f'(L_U^*) - w_U + (1 - L_U^*) = 0. \qquad ...(4)$$

Clearly, L_U^* is a function of $\theta: L_U^*(\theta)$.

Lemma 1

$$\frac{dR}{d\theta} < 0.$$

The above result is clear. Differentiating (4), $\frac{dL}{d\theta} = \frac{f'}{1 - \theta f''} > 0$. Hence, $\frac{dR}{d\theta} = -\frac{dL}{d\theta} < 0$. The severer a recession is, the stronger the resistance of the union is.

Denote the critical point of the firm's state in which full employment is realized under the union case as $\theta^{**} \equiv \frac{w_U}{f'(1)}$. Under $\theta^{**} \le \theta \le \overline{\theta}$, it holds that $L_U = 1$. In summary, the following severance pay R and employment levels L_U are realized as a Nash equilibrium:

$$\begin{aligned} &R = 1 - L_U^*(\theta) \quad and \quad L_U(\theta) = L_U^*(\theta) \quad if \quad 0 < \theta < \theta^{**} \\ &\quad R = 0 \quad and \quad L_U(\theta) = 1 \quad if \quad \theta^{**} \le \theta \le \overline{\theta}. \end{aligned} \qquad ...(5)$$

Next consider workers' *ex ante* expected utility and the firm's expected profit. A worker's expected utility with the union is represented by

$$\begin{aligned} U_U &\equiv \int_0^{\overline{\theta}} \left\{ L_U(\theta) w_U + R(1 - L_U(\theta)) - \frac{R^2}{2} \right\} \overline{\phi}(\theta) d\theta - K - c \\ &= \int_0^{\theta^{**}} \left\{ L_U^*(\theta) w_U + \frac{(1 - L_U^*(\theta))^2}{2} \right\} \overline{\phi}(\theta) d\theta + (1 - \overline{\Phi}(\theta^{**})) w_U - K - c \end{aligned} \qquad ...(6)$$

where $\overline{\phi}(\theta)$ or $\overline{\Phi}(\theta)$ is the density or distribution function of the state when all workers have delivered efforts. Thus, individual rationality of workers under perfect information on workers' efforts is $U_U \ge 0$, ...(7)

where the reservation utility is normalized to 0. The unionized firm's expected profit is

$$\begin{aligned} \Pi_U &\equiv \int_0^{\overline{\theta}} \pi_U(\theta) \overline{\phi}(\theta) d\theta \\ &= \int_0^{\theta^{**}} \left[\theta f(L_U^*(\theta)) - w_U L_U^*(\theta) - (1 - L_U^*(\theta))^2 \right] \overline{\phi}(\theta) d\theta, \\ &\quad + \int_{\theta^{**}}^{\overline{\theta}} \left[\theta f(1) - w_U \right] \overline{\phi}(\theta) d\theta \end{aligned}$$

It is clear that the firm's profit is a decreasing function with w_U. Thereby, individual rationality (7) is always binding. Hence, w_U is determined with $U_U = 0$.

Non-Union case

If a union is not organized, workers without bargaining power cannot resist the firm's dismissal policy and obtain any severance pay. In this case, employment level is determined as follows:

$$L_F = \min\left\{1, (f')^{-1}\left(\frac{w_F}{\theta}\right)\right\}, \qquad ...(8)$$

where L_F and w_F are employment level and wage in the non-union case. In this case, if $\theta \ge \theta^* \equiv \frac{w_F}{f'(1)}$, $L_F(\theta) = 1$. Under $\theta < \theta^*$, $L_F(\theta) = L_F^*(\theta) \equiv (f')^{-1}\left(\frac{w_F}{\theta}\right)$. The expected utility of workers is as follows:

$$U_F = \int_0^{\theta^*} w_F L_F^*(\theta)\bar{\phi}(\theta)d\theta + (1-\bar{\Phi}(\theta^*))w_F - c,$$

where U_F is denoted as a worker's expected utility without unions. Individual rationality is $U_F \geq 0$. ...(9)

The firm's profit is as follows,

$$\Pi_F = \int_0^{\theta^*} \left[\theta f(L_F^*(\theta)) - w_F L_F^*(\theta)\right]\bar{\phi}(\theta)d\theta + \int_{\theta^*}^{\bar{\theta}} \left[\theta f(1) - w_F\right]\bar{\phi}(\theta)d\theta \quad ...(10)$$

Since the firm's profit decreases with w_F, (9) is always binding.

Here, consider a fixed cost level of the unions activities. We assume the fixed cost level throughout this paper as follows:

$$K = K_0 \equiv \int_0^{\bar{\theta}} \frac{(1-L_U(\theta))^2}{2}\bar{\phi}(\theta)d\theta \quad ...(11)$$

Equation (11) implies that net effect of the union to the expected utility of a worker is zero. If the net effect is negative: $K>K_0$, workers are unwilling to organize the union. On the other hand, if it is positive: $K<K_0$, a proposition mentioned later will be strengthened. Under (11), the expected utility of a worker with the union is replaced by

$$\begin{aligned} U_U &= \int_0^{\bar{\theta}} \left\{L_U(\theta)w_U\right\}\bar{\phi}(\theta)d\theta - c \\ &= \int_0^{\theta^{**}} \left\{L_U^*(\theta)w_U\right\}\bar{\phi}(\theta)d\theta + (1-\bar{\Phi}(\theta^{**}))w_U - c. \end{aligned} \quad ...(6)'$$

Under (11), the following lemma holds.

Lemma 2

It holds under (11) that

[1] $w_U < w_F$

[2] $\theta^* > \theta^{**}$

[3] $\forall\theta \in (0, \theta^{**})$ $\quad 1 > L_U(\theta) > L_F(\theta)$

$\forall\theta \in [\theta^{**}, \theta^*)$ $\quad L_U(\theta) = 1 > L_F(\theta)$

$\forall\theta \in [\theta^*, \bar{\theta}]$ $\quad L_U(\theta) = L_F(\theta) = 1$

Proof

See Appendix.

Lemma 2 indicates that full employment is more likely with unions than without unions. Lemma 2 [2] and [3] are reasonable since unions raise severance pay as firing cost. These results are consistent with empirical studies: Freedman and Medoff (1984), Muramatsu (1983) (1984), Brunello (1992), Blanchflower and Freeman (1992), Tomita

(1993), and Koike (1991). These studies find that union effects decrease employees' quit rate. However, you may think that this is inconsistent with payment in the real world since it indicates that the wage at firms with unions is less than at firms without unions. Intuitively, it seems that the unions' bargaining power raises wage. However, opinions are divided on unions' effect on increasing wage. As Freeman (1994) and Tachibanaki (1998) indicate, the union-nonunion wage gap in the U.S. is exceptionally large, whereas, in other developed countries, the union effect of increasing wage is small or negative. Indeed, there are studies which reject this union effect of increasing wage; Brunello (1992), Valleta (1993), Tsuru and Rebitzer (1993), Tachibanaki and Noda (1993), and Kishi (1995). The result of lemma 2 [1] is introduced from the policy of the union which attaches much weight to workers' job security. As a cause of the union's policy attaching much weight to job security, we point out the entry deterrence policy of unionized firms. The threat of entry by rival firms prevents unions from raising wage. If rival firms intend to enter the market, the unions may accept a lower wage in order to deter entry. As Ishiguro and Shirai (1998) show, entry deterrence policy forces unions to pay more attention to job security rather than to obtaining high wages.

Next, compare profit of a non-union firm to that of a unionized firm. First, consider profit of a non-union firm. Using the envelope theorem, it holds that $\frac{\partial \pi_F}{\partial \theta} = f(L_F) > 0 \quad and \quad \frac{\partial^2 \pi_F}{\partial \theta^2} = f'(L_F) L_F'(\theta) > 0$ under $0 < \theta < \theta^*$. Hence, under $0 < \theta < \theta^*$, π_F is a convex function with respect to θ. Under $\theta^* \le \theta \le \overline{\theta}$, π_F is a linear function from $\frac{\partial \pi_F}{\partial \theta} = f(1) = const. > 0$. Clearly, $\pi_F(0) = 0$. Therefore, profit of a non-union firm is represented in figure 3.

Next, consider a unionized firm. Under $0 < \theta < \theta^{**}$, using $\frac{dL_U(\theta)}{d\theta} = \frac{f'}{1 - \theta f''} > 0$, it holds that $\frac{\partial \pi_U}{\partial \theta} = f(L_U) + (1 - L_U) L_U'(\theta) > 0$. Obviously, $\pi_U(\theta)$ is linear under $\theta^{**} \le \theta \le \overline{\theta}$.[2] Furthermore, it holds that $L_U(0) = 0 \quad and \quad \pi_U(0) = -1$.[3]

When the state of the firm is severe, profit of the non-union firm is more than that of the unionized firm. On the other hand, in booms, the unionized firm gets more profit by

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[2] Under $0 < \theta < \theta^{**}$, $\pi_U(\theta)$ is not necessarily a convex function with respect to θ.

[3] This result is introduced as follows. Suppose that $w_U \le R = 1 - L_U$ on the equilibrium. In this case, full employment is optimal for any state. Hence, $w_U \le 0$. This contradicts individual rationality (7), and thus it holds that $w_U > R = 1 - L_U$ on the equilibrium. The firm's optimal employment level under $\theta = 0$ is $L_U(0) = 0$. Hence, it holds that R=1 and $\pi_U(0) = -1$.

$w_U < w_F$. In figure 3, the case wherein the curve π_U and the curve π_F cross at a unique point $\hat{\theta}$ is represented. From figure 3, the existence of unions might increase expected profit. For example, consider a case of high workers' efforts cost in which individual rationality under the non-union case is not satisfied, but individual rationality under the union case is satisfied. This case, as figure A-1 suggests, can occur. Under the non-union case, $\Pi_F = 0$ because contracts are not enforceable, while under the union case, $\Pi_U > 0$. Under contractual incompleteness, contracts are not enforceable without unions because the firm optimizes the employment level *ex post*. However, the existence of unions makes contracts enforceable, and the union exercising power on job security enhances the firm's profit.

Here, we consider the first best case as a benchmark. Social welfare is represented as follows:

$$W = \int_0^{\bar{\theta}} \left[\theta f(L(\theta)) - \frac{R^2}{2} \right] \bar{\phi}(\theta) d\theta - K - c. \qquad ...(12)$$

Hence, the first best allocation is expressed by

$$\forall \theta \in (0, \bar{\theta}] \quad L(\theta) = 1 \quad and \quad R = 0.$$

Union members have higher job security than non-members. The effect of unions on job security improves social welfare. On the other hand, The cost of union activities decreases social welfare. Therefore, if the former positive effect exceeds the latter negative one, firms' profits increase by the existence of unions.

Proposition

There are cases wherein the expected profit of the unionized firm exceeds that of the non-union firm if workers' efforts cost c is sufficiently high: $\Pi_U > \Pi_F$.

Firms lose the free controllability of employment level *ex post*, and thus the union decreases the firm's profit *ex post* under $\theta \in (0, \bar{\theta}]$. However, unions play a significant role in job security of employees. Since unions raise employment stability, firms can lower basic wage *ex ante*, and unions would then be welcomed by firms.[4]

[4] If unions focus on increasing basic wage in the original contract, they try to obtain a wage level that will maximize the expected utility. However, firms in this case do not wish for unions since the increase of basic wage decreases firms' profits, and firm managers are willing to discourage workers from organizing and managing unions.

3. Imperfect Signal and Incentives

We have considered the case of perfect information on employees' actions: a firm can distinguish whether a worker is shirking or not. Unless this is so, the previous results might be modified.

Suppose that a firm cannot observe workers' efforts level but can observe an imperfect unverifiable signal on their efforts level. Denote density or distribution function of states in the case wherein *all* workers have delivered high efforts level $\bar{e}$ as $\overline{\phi}(\theta)$ or $\overline{\Phi}(\theta)$. Density or distribution function of states in the case wherein *some* workers have shirked and provided low efforts level is $\underline{\phi}(\theta)$ or $\underline{\Phi}(\theta)$. Density function $\overline{\Phi}(\theta)$ is the first order stochastic dominant to $\underline{\Phi}(\theta)$.

If all workers have made efforts, the firm receives a good signal $s = \bar{s}$ with possibility q $(0.5 < q < 1)$ or a bad one $s = \underline{s}$ with possibility 1-q at no cost. Otherwise, even if only one worker shirks, the firm observes a bad signal $s = \underline{s}$ with possibility q or a good one $s = \bar{s}$ with possibility 1-q. Signal $\bar{s}$ ($\underline{s}$) implies imperfectly that all workers have made efforts (or not). The firm receives signals on the workers' efforts level after workers have chosen their actions, and then the firm decides whether to continue or not. If the firm ceases the industrial relation, zero profit is realized. On the other hand, if the employment relation proceeds, Nature chooses a state observable by workers and the firm. See figure 4 on timing of decisions by workers and the firm. The signal may influence on the firm's choice on whether to continue or not.

Signal Case

First, we consider the case wherein the firm decides whether to continue by operating based on the signal: the firm chooses to continue if the firm receives the good signal $\bar{s}$, otherwise the firm deviates from the individual relationship. In this case, the group of workers chooses the mixed strategy on the level of efforts on equilibria. Note that the firm's signal based determinant is not the best response if the group of workers chooses the pure strategy. If workers are willing to make efforts with probability 1, the firm has an incentive to continue regardless of the signal, whereas, if they always shirks, the firm is willing to cease.

Denote the probability that the group of workers makes efforts $e = \bar{e}$ as m. In this paper, it is assumed that all workers choose an identical action by proper communication. When the firm receives the good signal $\bar{s}$, using Bayse's rule, the conditional probability whereby all workers have made efforts is

$p(\bar{e}|\bar{s}) = \dfrac{mq}{mq+(1-m)(1-q)}$. If $s=\underline{s}$, the conditional probability is $p(\bar{e}|\underline{s}) = \dfrac{m(1-q)}{m+q-2mq}$ (See figure 5). The expected profit conditional signal s is expressed by

$$\Pi_j(m,\ s) \equiv p(\bar{e}|s)E(\pi_j(\theta)|\bar{e}) + p(\underline{e}|s)E(\pi_j(\theta)|\underline{e}) \qquad j = U\ or\ F.$$

Furthermore, when the firm's signal based operation is optimal, it is necessary to hold the following condition in either case with or without a union:

$$\Pi_j(m,\ \underline{s}) < 0 < \Pi_j(m,\ \bar{s}) \qquad j = U\ or\ F \qquad ...(13)$$

Here, define the levels of the probability $\underline{m}_j$, $\overline{m}_j$ as follows:

$$\Pi_j(\underline{m}_j,\ \underline{s}) = 0 \ \ and \ \ \Pi_j(\overline{m}_j,\ \bar{s}) = 0 \qquad j = U\ or\ F.$$

Condition (13) is replaced by

$$\underline{m}_j > m > \overline{m}_j \qquad j = U\ or\ F \qquad ...(13)'$$

When (13)' does not hold, the firm will not use the signal based operation.[5] If the firm faces a bad signal under (13)', the firm will have no incentive to continue the industrial relationship, and then zero profit is realized and workers get nothing.

The less precise the signal, the less likely it is that workers will make efforts. When the signal is very imperfect employees are likely to shirk since firms face the difficulty of recognizing employees' efforts level, and firms would not use the signal based operation. We consider this case later.

When the signal is not imperfect very much the firm will use the signal based operation. If the firm receives the good signal $\bar{s}$, the firm continues employing workers. Otherwise, the firm is unwilling to continue. In this case, workers' individual rationality with the union is as follows:

$$\begin{aligned} U_U \equiv\ & m\left[q\int_0^{\bar{\theta}} \left\{ w_U L_U(\theta) + R(1-L_U(\theta)) - \frac{R^2}{2} - K \right\} \bar{\phi}(\theta) d\theta - c \right] \\ & + (1-m)\left[(1-q)\int_0^{\bar{\theta}} \left\{ w_U L_U(\theta) + R(1-L_U(\theta)) - \frac{R^2}{2} - K \right\} \underline{\phi}(\theta) d\theta \right] \geq 0 \end{aligned} \qquad ...(14)$$

Using (3) and (11), individual rationality (14) is replaced by

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[5] It always holds that $\underline{m}_j > \overline{m}_j$ $(j = U\ or\ F)$. By the definition,

$$\underline{m}_j = \frac{-qE(\pi_j|\underline{e})}{(1-q)E(\pi_j|\bar{e}) - qE(\pi_j|\underline{e})} \ \ and \ \ \overline{m}_j = \frac{-(1-q)E(\pi_j|\underline{e})}{qE(\pi_j|\bar{e}) - (1-q)E(\pi_j|\underline{e})}.$$

Then,

$$\underline{m}_j - \overline{m}_j = \frac{(1-2q)E(\pi_j|\bar{e})E(\pi_j|\underline{e})}{\left\{(1-q)E(\pi_j|\bar{e}) - qE(\pi_j|\underline{e})\right\}\left\{qE(\pi_j|\bar{e}) - (1-q)E(\pi_j|\underline{e})\right\}}.$$

By q>0.5 and (1), it is obtained that $\underline{m}_j > \overline{m}_j$.

$$U_U = m\left[q\int_0^{\bar{\theta}} w_U L_U(\theta)\bar{\phi}(\theta)d\theta - c \right] + (1-m)\left[(1-q)\int_0^{\bar{\theta}} w_U L_U(\theta)\underline{\phi}(\theta)d\theta \right] \geq 0 \quad ..(14)'$$

Since workers choose the mixed strategy, it holds that

$$q\int_0^{\bar{\theta}} w_U L_U(\theta)\bar{\phi}(\theta)d\theta - c = (1-q)\int_0^{\bar{\theta}} w_U L_U(\theta)\underline{\phi}(\theta)d\theta > 0 .$$

This implies that workers are indifferent to making efforts. Clearly, individual rationality (14) is not binding. If the above equation does not hold, workers are always willing to make efforts or always have an incentive for shirking. Then, the signal based operation is not optimal for the firm. The above equation is replaced by

$$I_U(w_U) \equiv \int_0^{\bar{\theta}} w_U L_U(\theta)\left\{ q\bar{\phi}(\theta) - (1-q)\underline{\phi}(\theta) \right\} d\theta = c . \qquad ...(15)$$

In the same manner, individual rationality without the union is considered,

$$U_F = m\left[q\int_0^{\bar{\theta}} w_F L_F(\theta)\bar{\phi}(\theta)d\theta - c \right] + (1-m)\left[(1-q)\int_0^{\bar{\theta}} w_F L_F(\theta)\underline{\phi}(\theta)d\theta \right] \geq 0 .$$

Under the mixed strategy, it holds that

$$I_F(w_F) \equiv \int_0^{\bar{\theta}} w_F L_F(\theta)\left\{ q\bar{\phi}(\theta) - (1-q)\underline{\phi}(\theta) \right\} d\theta = c . \qquad ...(16)$$

If (13)' is satisfied, the firm is to determine by the signal whether to continue or not, and workers randomize their efforts level at the probability m. This forces a perfect Bayesian equilibrium.

You may think $I_U(w) > I_F(w)$ in a manner similar to the perfect information case. However, note that the sign of $\left\{ q\bar{\phi}(\theta) - (1-q)\underline{\phi}(\theta) \right\}$ is ambiguous. The distribution function of the state contingent on efforts level, and the production function influence the levels of $I_U(w)$ and $I_F(w)$. Thus, the sign of $I_U(w) - I_F(w)$ is ambiguous. Therefore, it is not always obtained that $w_U < w_F$: the wage difference between the union case and the non-union case depends upon the distribution function and the production function. This result is contrary to that seen under perfect information on workers' efforts, where it *always* holds that $w_U < w_F$. Note that $w_U < w_F$ is a necessary condition whereby unions are welcomed by firms if the same mixed strategy m is chosen. The firm loses free controllability of employment level by existence of the union. Hence, if the firm's profit is enhanced by the union, it is necessary to hold $w_U < w_F$.[6] We can show that profit of the unionized firm is less than that of the non-union firm for any state if $w_U > w_F$. Clearly, the following inequalities hold:

[6] Clearly, as we have shown in the previous chapter, $w_U < w_F$ is not sufficient to hold $\Pi_U > \Pi_F$.

$$\begin{aligned}\pi_U(\theta) &\equiv \theta f(L_U) - w_U L_U - R(1-L_U) \\ &< \theta f(L_U) - w_U L_U \\ &< \theta f(L_U) - w_F L_U \qquad (\because w_U > w_F) \\ &< \theta f(L_F) - w_F L_F \equiv \pi_F(\theta)\,.\end{aligned}$$

The last inequality is obtained from the viewpoint that L_F is the optimal employment level of the firm given w_F. Therefore, information asymmetry weakens the role of the union as a commitment device.

No signal case

The firm might not use the signal based operation. In this case, the firm offers a wage level which encourages employees to make efforts:

$$\begin{aligned}&\int_0^{\bar{\theta}} \left\{ w_U L_U(\theta) + \frac{(1-L_U(\theta))^2}{2} - K \right\} \bar{\phi}(\theta) d\theta - c \\ &\qquad \geq \int_0^{\bar{\theta}} \left\{ w_U L_U(\theta) + \frac{(1-L_U(\theta))^2}{2} - K \right\} \underline{\phi}(\theta) d\theta\end{aligned} \quad . \qquad \text{...(17)}$$

Using (11), (17) is replaced as follows:

$$\tilde{I}_U(w_U) \equiv \int_0^{\bar{\theta}} w_U L_U(\theta) \left\{ \bar{\phi}(\theta) - \underline{\phi}(\theta) \right\} d\theta \geq c\,. \qquad \text{...(17)'}$$

In the same manner, incentive compatibility without a union is

$$\tilde{I}_F(w_F) \equiv \int_0^{\bar{\theta}} w_F L_F(\theta) \left\{ \bar{\phi}(\theta) - \underline{\phi}(\theta) \right\} d\theta \geq c\,. \qquad \text{...(18)}$$

Obviously, comparing (17)' and (18) with (15) and (16), a similar result can be obtained: it does not always hold $w_U < w_F$.

An example

We can show a simple example of $w_U > w_F$ under the imperfect signal case. Two states, a boom and a recession, exist: $\bar{\theta} > \underline{\theta} > 0$. If all workers make efforts, the probability of a boom or a recession is 0.5, otherwise, a recession always occurs. From a viewpoint of backward induction consideration, consider the determinant of employment level given wage level after the state is observed. Throughout this example, it is assumed that a boom is good enough to occur full employment, and that a recession is sufficiently severe to be unwilling to maintain full employment regardless of the unionized firm. In the union case, this assumption implies that the following inequalities hold on the equilibrium:

$$\bar{\theta} f'(1) - w_U > 0, \quad and \quad \underline{\theta} f'(1) - w_U < 0\,.$$

In a manner similar to the previous section, employment level is realized as follows:

$$L_U(\bar{\theta}) = 1 \;\; and \;\; L_U(\underline{\theta}) = L_U^*$$

where it is satisfied that $\underline{\theta} f'(L_U^*) - w_U + (1 - L_U^*) = 0$. Under this example, (11) is represented as follows:

$$K_0 \equiv \frac{(1 - L_U^*)^2}{4}.$$

Individual rationality under the mixed strategy is represented by

$$U_U \equiv m\left[\frac{q}{2} w_U (1 + L_U^*) - c\right] + (1 - m)\left[(1 - q) w_U L_U^*\right] \geq 0$$

where the reservation wage is zero in the same manner as in the previous chapter. We assume that there are some proper probability levels $m \in (0, 1)$ wherein the signal based operation is the best response for the firm. Thus, it holds $\frac{q}{2} w_U (1 + L_U^*) - c = (1 - q) w_U L_U^*$, and hence it is obtained that

$$I_U(w_U) \equiv w_U \left\{\frac{q}{2} + \left(\frac{3q}{2} - 1\right) L_U^*\right\} = c. \qquad ...(19)$$

Next, consider the non-union case. The following inequalities hold on the equilibrium:

$$\overline{\theta} f'(1) - w_F > 0, \quad and \quad \underline{\theta} f'(1) - w_F < 0.$$

Thus, it holds that

$$L_F(\overline{\theta}) = 1 \quad and \quad L_F(\underline{\theta}) = L_F^* (< 1) \qquad ...(20)$$

where $L_F^* = (f')^{-1}\left(\frac{w_F}{\underline{\theta}}\right)$. Without unions, it holds in the same manner that

$$I_F(w_F) \equiv w_F \left\{\frac{q}{2} + \left(\frac{3q}{2} - 1\right) L_F^*\right\} = c. \qquad ...(21)$$

If $q \geq \frac{2}{3}$, the left hands of (19) and (21) are positive. If $q < \frac{2}{3}$, the left hands of (19) and (21) decrease with L_U and L_F, and thus the minimum $2q$-1 is realized under L_U=1 or L_F=1. Using q>0.5, it is obvious that the left hands of (19) or (21) are positive. Therefore, the left hands of each are always positive for any $q \in (0.5, 1)$.

Here, in the same manner as the proof of lemma 2, suppose that w_U and w_F are equal. Under w_U=w_F=w, the existence of unions leads to high job security in a recession: $L_U^* > L_F^*$. Hence, if $q > \frac{2}{3}$, it holds for any wage level that

$$I_U(w) > I_F(w) \quad for\ any\ w\ (> 0). \qquad ...(22)$$

Thus, it is obtained that $w_U < w_F$ under $q > \frac{2}{3}$.

However, if $q < \frac{2}{3}$, the following inequality (23) holds instead of (22) by $L_U^* > L_F^*$:

$$I_U(w) < I_F(w) \quad for\ any\ w\ (>0). \qquad ...(23)$$

In this case, (23) leads to $w_F < w_U$. (See figure 6.) Therefore, the existence of unions always decreases the *ex ante* expected profit of the firm.

When the imperfect signal is precise enough, $w_U < w_F$ holds. On the other hand, when the signal is not precise enough, it holds that $w_F < w_U$. Under the imprecise signal, the possibility of dismissal gives an incentive to employees. The threat of dismissal in recessions encourages workers to provide the necessary level of efforts. However, the existence of unions which resist to obtain severance pay in recessions will discourage workers from making efforts. Hence, higher wage induces workers to make efforts since unions give employees high job security. Without unions, workers have less job security, and thus they have incentives for making efforts while they get lower wage. This is similar to the result of the efficiency wage model (Shapiro and Stiglitz (1984)). In the efficiency model, the threat of dismissal is brought from partial monitoring. If a worker shirks and are unluckily caught by firm managers, he is dismissed and receives no payment as the result of the punishment of his shirking activity. However, if a shirking worker is not monitored fortunately, he is not dismissed. Monitoring is very crucial. In our model, the threat of dismissal exists for workers under even no monitoring. Under contractual incompleteness, the firm cannot promise to keep job security high in recessions. The possibility of dismissal in recessions is encouraged workers to make efforts; workers are willing to increase the probability of booms by their efforts. High job security and high payment under the union case decrease the profits of firms. Therefore, firms are unlikely to wish for the existence of unions under the imperfect signal case.[7]

4. Discussion: Blue Collar and White Collar

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[7] A similar result is easily obtained when the signal based operation is not used. In the no signal case, incentive compatibility is represented under (3) and (11) as follows:

$$\frac{w_j}{2}(1+L_j^*) - c \geq w_j L_j^* \qquad j = U \ or \ F.$$

Thus, incentive compatibility is replaced by

$$\tilde{I}_j(w_j) \equiv \frac{w_j}{2}(1-L_j^*) \geq c \qquad j = U \ or \ F.$$

In a similar manner, it is obtained by $L_U^* > L_F^*$ under $w_U = w_F = w$ that

$$\tilde{I}_U(w) \equiv \frac{w}{2}(1-L_U^*) < \frac{w}{2}(1-L_F^*) \equiv \tilde{I}_F(w) \quad for\ any\ w\ (>0).$$

Thus, $w_U > w_F$.

In the early twentieth century when the service industry was not so large, the share of white collar employees in the workforce was low, and thereby white collar employees stood at a middle position between firm managers and blue collar workers. As Mills (1951) pointed out, while they were hired as employees by firm managers, they were likely to behave as agents of managers to blue collar employees. White collar employees had a kind of dignity and could exercise power over blue collar employees like managers. Hence, white collar workers rarely belonged to unions organized and managed by blue collar workers. However, as the transition of the industrial structure occurs and the service industry grows, clerical and service workers have increased and their dominant position over blue collar workers has disappeared. Under these environmental changes, unions have been willing to involve white collar workers. Thus, it appears that unions have involved white collar workers, and yet their union membership rate has been lower compared to that of blue collar workers. Farber (1983) points out that clerical and service workers who desire union representation are significantly less likely to be hired by unionized firms than blue collar workers who desire union representation.

We have considered the role of unions as a commitment device. It has been shown that unions are more likely to play a significant role as a commitment device under perfect information on workers' actions than under imperfect signals. We will now attempt to extend this result into the idea that unions are more often organized and managed by blue collar workers than by white collar workers.

Indeed, it is more difficult to measure outputs and skills of white collar workers than blue collar workers since jobs of white collar workers are not always directly linked to outputs. This includes jobs in personnel departments, general affairs departments, public information sections, and accounting sections. Koike (1997) points out that white collar workers are required to accumulate skills at the workshop. Aoki and Okuno (1996) define white collar employees' skills as contextual skills which are shaped in workers' partnerships and are effective only through human relationships in the workshops. The measurement cost of white collar workers' skills will be higher than the cost of blue collar workers. Indeed, there are studies which support the above statement on the measurement cost of white collar workers' skills. According to Lazear's shirking hypothesis on wage profiles (Lazear (1979) (1981)), the difficulty of monitoring workers leads to delayed compensation schemes which gives workers incentives. Actually, the wage profiles of white collar workers are more upward-sloping than those of blue collar workers in Japan and the U.S. (Shimada (1981)). Eguchi (2000b) shows that the difficulty

of measuring workers' actions leads to more upward-sloping wage profile and high job security which are the characteristics of white collar workers. Therefore, the signal on workers' actions is less likely to be precise and correct at the workshops of white collar workers compared to those of blue collar workers.

Less perfect signals on workers' actions lowers the role of unions as a commitment device, and thus firms are unlikely to wish for unions. As Freeman and Rebick (1989) and Farber (1990) find, allowance of firm managers is very crucial to setting up unions in the real world. Therefore, it can be explained why unions are more often organized and managed by blue collar workers than by white collar workers by the fact that firm managers can observe blue collar workers' efforts level better than that of white collar workers.

5. Conclusion

In this paper, we have provided a new role of unions focusing on unions' power. Under contractual incompleteness, firms cannot promise high job security to its workers in recessions. Firms always optimize employment level *ex post*. However, if unions exercise their power to obtain high severance pay, firms can promise to keep employment level high as a result of unions' role as a commitment device. Thus, firms can decrease basic wage and provide high job security, and firms' profits increase.

Furthermore, we extend the model to the case of imperfect signals on employees' actions and show that signal imperfection weakens the role of unions as a commitment device. Uncertainty on job security, that is, the possibility of dismissal, encourages workers to make efforts. Hence, since unions keep job security high, a moral hazard problem is likely to occur. Existence of unions weakens the workers' incentives, and thus unions are likely to decline firms' profits. This explains the observed fact that unions are more likely to be organized and managed by blue collar workers than by white collar workers. Jobs of white collar workers are rarely linked to outputs of the firm directly, for example, jobs in public information sections or accounting sections. Therefore, firm managers cannot often distinguish whether white collar workers have made appropriate efforts, and thus do not wish for the existence of unions under signal imperfection and will hinder unions' members and prevent unions' activities. Actually, firm managers' affirmative attitude to organizing unions is very crucial in the real world. Hence, white collar workers are more likely to be discouraged from organizing, managing, and participating in unions than blue collar workers.

Appendix

Proof of lemma 2

[1] Suppose that $w_U = w_F = w$. It holds by R>0 that

$$L_U(\theta) = \min\left\{1, (f')^{-1}\left(\frac{w-R}{\theta}\right)\right\} \geq \min\left\{1, (f')^{-1}\left(\frac{w}{\theta}\right)\right\} = L_F(\theta).$$

Furthermore, $\theta^* \equiv \frac{w}{f'(1)} > \frac{w-R}{f'(1)} \equiv \theta^{**}$ holds. Hence, it is realized that $L_U(\theta) = L_F(\theta) = 1$ under $\theta^* \leq \theta \leq \overline{\theta}$ and $L_U(\theta) = 1 > L_F(\theta)$ under $\theta^{**} \leq \theta < \theta^*$. Finally, consider the case under $0 < \theta < \theta^{**}$. In this case, it is obtained that $L_U(\theta) = (f')^{-1}\left(\frac{w-R}{\theta}\right) > (f')^{-1}\left(\frac{w}{\theta}\right) = L_F(\theta)$. Hence, employment level for any state with the union is higher than that without the union, and thereby it holds that $U_U(w) > U_F(w)$ (see figure A-1). If $w \leq c$, it is clear that $0 > U_U(w) > U_F(w)$. Hence, if $U_U(w)$ and $U_F(w)$ are continuous, and contracts with the unionized firm are enforceable, it holds that $\frac{dU_U}{dw_U} \geq 0$ at the minimum solution w_U of $U_U(w_U) = 0$, and when $U_F(w_U) < 0$ (See figure A-1). Since the firm maximizes its profit, it chooses the minimum wage that satisfies individual rationality. Thus, it is obtained that $w_U < w_F$.

[2] Obviously, $\theta^* - \theta^{**} = \frac{w_F}{f'(1)} - \frac{w_U - R}{f'(1)}$.

From [1], it holds that $\theta^* > \theta^{**}$.

[3] Under $\theta^* \leq \theta \leq \overline{\theta}$, $L_U = L_F = 1$. It holds that $L_U(\theta) = 1 > L_F(\theta)$ under $\theta^{**} \leq \theta < \theta^*$. Under $0 < \theta < \theta^{**}$, using [1], it is obtained that $L_U(\theta) = (f')^{-1}\left(\frac{w_U - R}{\theta}\right) > L_F(\theta) = (f')^{-1}\left(\frac{w_F}{\theta}\right)$.■

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Timing

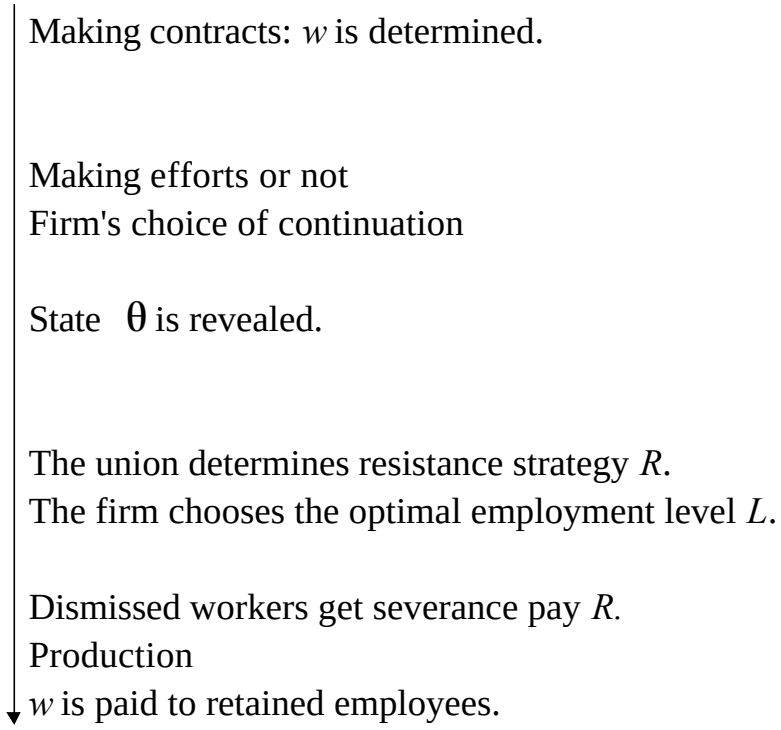

Figure 1

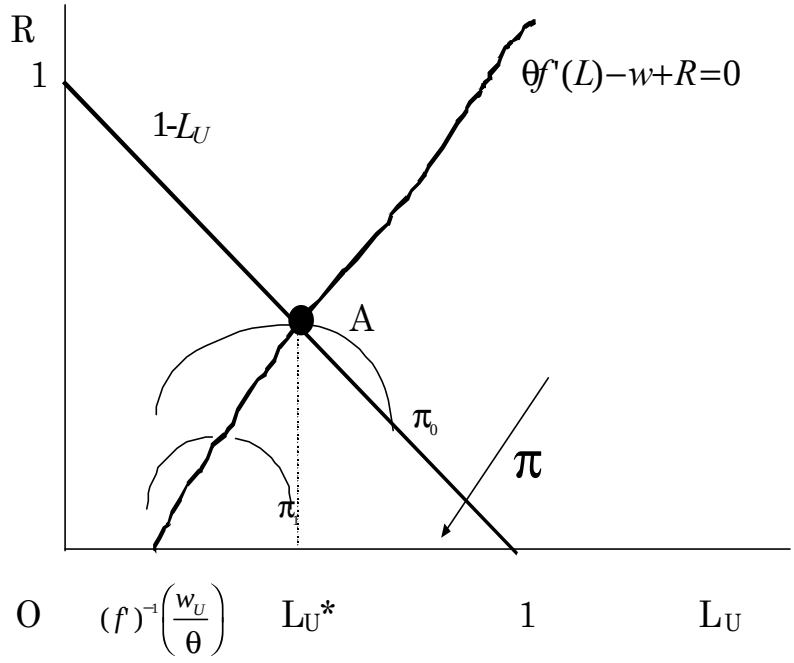

Figure 2

π_0 *and* π_1 are iso-profit curves: $\pi_1 > \pi_0$.

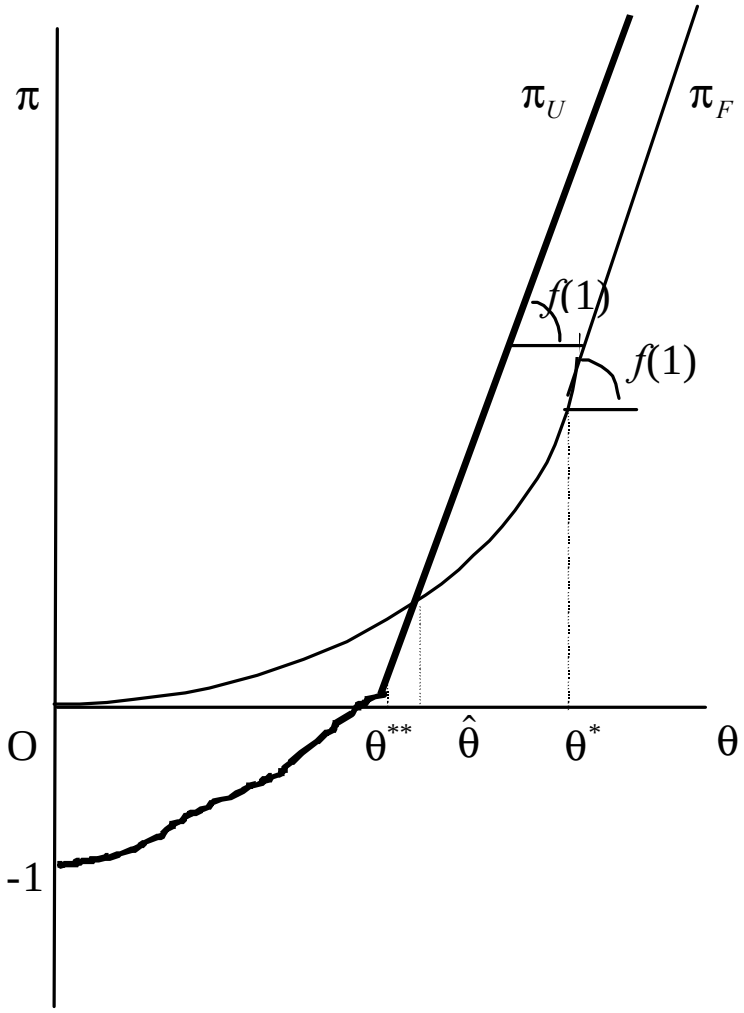

Figure 3

Timing

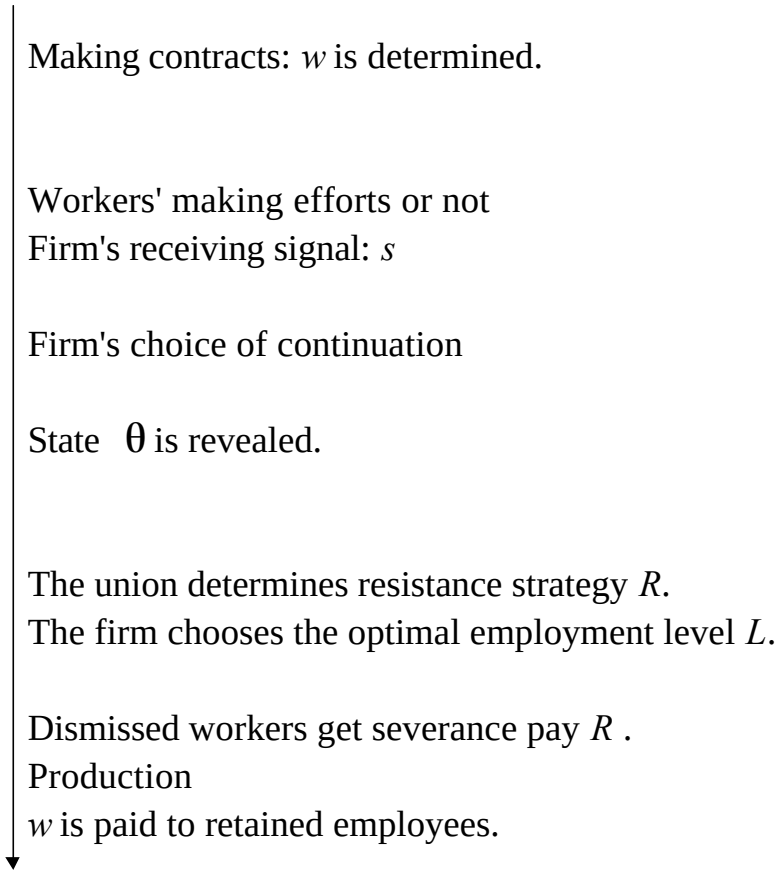

Figure 4

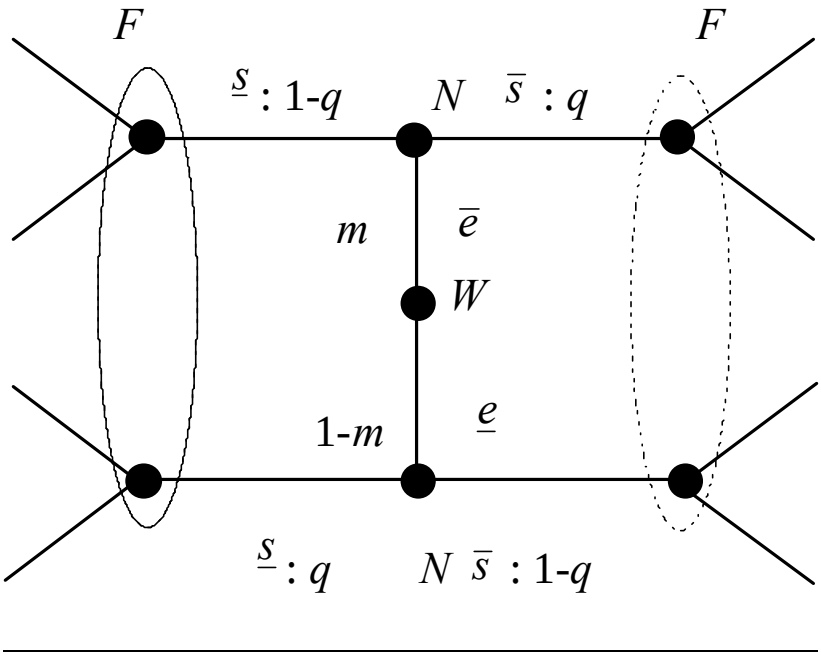

Figure 5

W: workers
N: Nature
F: firm

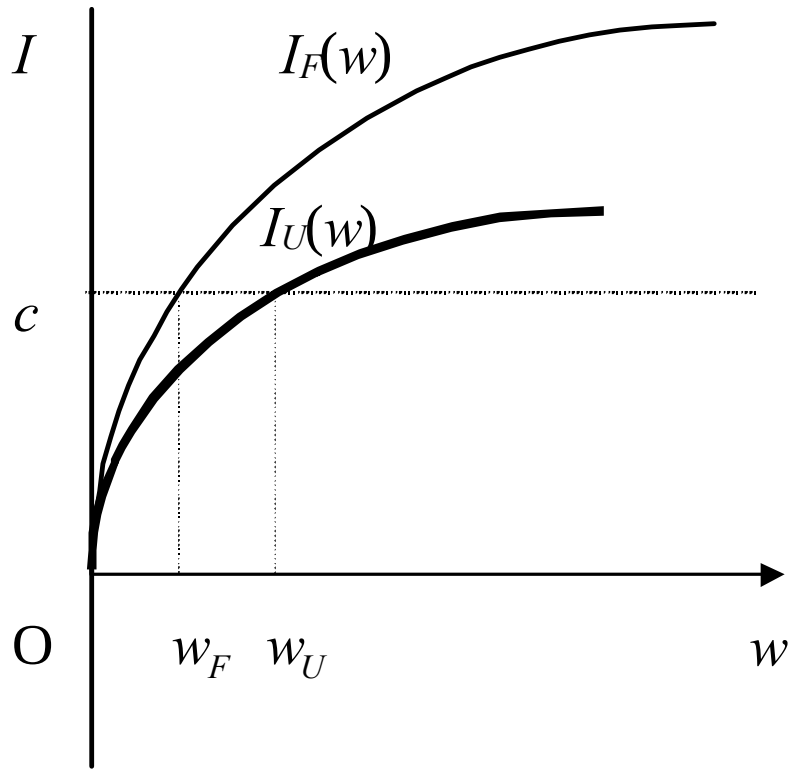

Figure 6

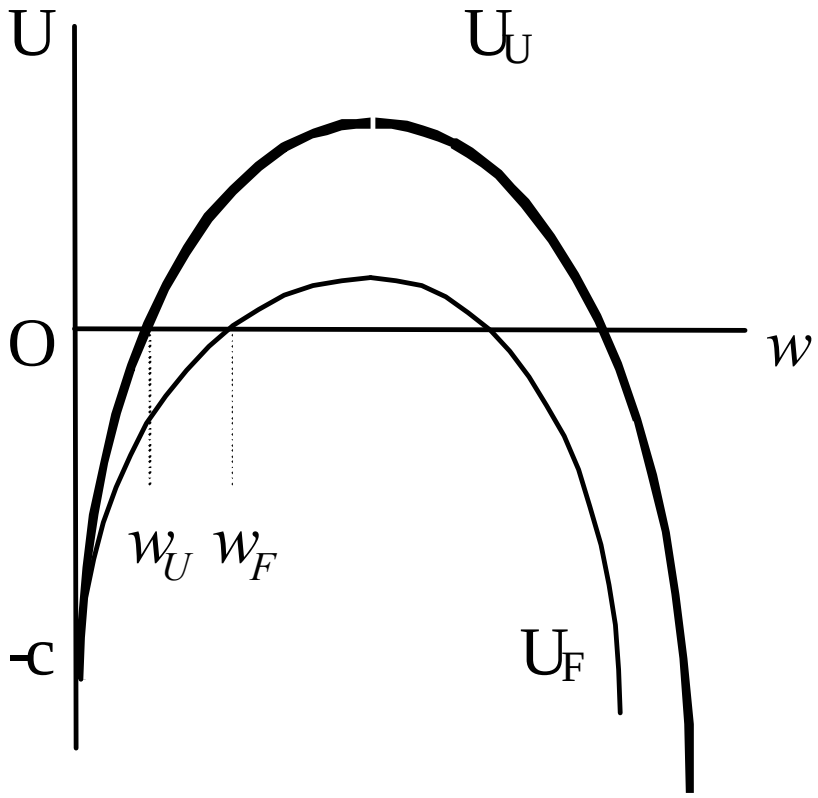

Figure A-1

Note that U_U and U_F are not always expressed in this manner. However, if w is sufficiently low, the expected utility of workers who have made efforts is negative even if high employment stability is realized. On the other hand, very high wage lowers job security, so that workers' expected utility is negative.