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Abstract

We consider why blue collar workers are more likely to organize unions than white collar workers from a view of commitment devices and the moral hazard problem. Under contractual incompleteness, a firm cannot promise to keep employment level high *ex ante*. However, if unions resist firms' dismissal policies, unions can play a significant role as commitment devices for job security. Then, since firms can decrease wage and increase employment level, the profit of firms with unions can be more than that without unions. Furthermore, we show that asymmetric information on workers' actions weakens the role of unions as commitment devices. The result explains the above question since efforts level of white collar workers is difficult to observe.

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1. Introduction

As Freeman and Medoff (1984) and Blanchflower and Freeman (1992) show, unions are less likely to be organized and managed by white collar employees compared to blue collar workers. Blanchflower and Freeman (1992) point out the difference of union membership rates between blue collar workers and white collar 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 blue collar workers and the latter is that of white collar workers. Our purpose here is to explain this difference by focusing on unions' role as commitment devices and the moral hazard problem. Recent studies consider commitment devices under incompleteness of contracts: delegation of authority by 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.

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, which means the basic wage is verifiable. However, workers face uncertainty in job security under the free dismissal principle supported by labor laws. The firm can dismiss employees under some restrictions determined by labor laws. Dismissal rates of employees contingent on the states cannot be described or determined *ex ante* in labor contracts due to bounded rationality or huge cost. Under contractual incompleteness, the 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. Hence, the firm always maximizes the *ex post* profit. Employees then take this into account when making contracts with the firm. When workers are required to make efforts at increasing the possibility of good states for the 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 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.

What effects do unions have on firms' behavior? If a union tries to keep

employment at a desirable level for workers, a firm cannot optimize its employment level since the union functions to maintain job security for the employees. If the goal of higher job security is realized by the union, then a low wage would cover workers' efforts cost, and the firm with the union will have a lower payment than that without the union. Therefore, the 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. Under incompleteness of contracts, unions might be welcomed by firms because a union acts as a commitment device. Indeed, as Koike (1977), Aoki (1988), and Odaka (1995) mention, while some unions have exercised a strong power to avoid dismissals and have had pitched battles with their firms' managers, the unions were apt to follow the firms' policy on wages obediently. For example, in 1954, a union in the Muroran Steel Mill of Nihon Seiko resisted a dismissal policy aggressively and took strike actions for 193 days. As Koike (1977) indicated, the union was likely to follow the firm's wage policy and was regarded as a weak and obedient union. Although the union was overcome in this severe dispute, the union's resistance during the dispute revealed to numerous firms' managers that attempts to dismiss employees can bring a union's resistance.

Furthermore, we extend the model to the case of asymmetric information on workers' actions. Under the existence of moral hazard, the above result is modified. High job security, which is brought by the union, may discourage workers from making efforts. Uncertainty of employment enhances workers' incentives under contractual incompleteness. If workers are never dismissed as the result of making explicit and verifiable contracts, they have no incentives for making efforts since shirking workers are never punished by the firm managers. Hence, under moral hazard, workers' motivations can be weakened by the existence of unions which try to keep job security high. We will provide a simple example and show that the moral hazard problem 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.

The difference of a union's effect under symmetric vs. asymmetric information may explain why blue collar workers more often organize, manage, and participate in unions than white collar workers. Indeed, outputs of blue collar workers are more observable than those of white collar workers. 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 moral hazard problem is more likely to occur at the workshop of white collar workers rather than that of blue collar workers. Firms are less willing to have white collar employees organize, manage, and participate in unions.

This paper is organized in the following manner. In chapter 2 and 3 we present the model and compare profits and job security in firms with unions to those without unions under no moral hazard. We will show that unions play a significant role as commitment devices, and, as such, the expected profit of firms with unions can be more than that of firms without unions. Chapter 4 focuses on the moral hazard case. In this case, firms are unwilling to wish for the existence of unions since existence of unions is likely to break the incentive scheme. In chapter 5, we discuss the characteristic differences and union membership rates between blue collar workers and white collar workers. Finally, our conclusions are set forth in chapter 6.

2. Basic Model

We focus on a union's resistance to dismissal by a firm.[1] As we mention later, after wage has been decided, both the union and the 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 raise the firm's dismissal cost by its various activities, for example, accusations of 'unfair' dismissal in the mass media, demonstrations and sit-ins. These actions of the union do damage to the firm's reputation and decrease its profit.

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

① First, the firm has a labor pool normalized to 1 and offers wage w to workers, when the wage is not yet paid. 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.

③ If workers have delivered efforts, the firm invests for workers' skills formation. The

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[1] Although wage barganing between unions and firms is important, for simplicity we do not consider it, allowing its effect to be seen easiliy. We mention this effect in chapter 3.

training investment of the firm induces workers to be effective in producing outputs. The investment makes labor inputs functional. Unless the firm invests, labor inputs produce nothing; the training investment of the firm is essential to production. The investment cost T is a constant.

④ Then, Nature chooses a state, and the firm and the union know the realized state $\theta \in (0, \overline{\theta}]$.

⑤ The union chooses a resistance strategy and the firm determines the optimal employment level. Their strategies are optimal to each other on the equilibrium.

⑥ If dismissal occurs, dismissed workers receive no payment. On the other hand, employees retained in the firm get the wage determined by the original contract.

The union determines its activity level R. For simplification, the firing cost of one employee is also expressed by R. If the firm dismisses (1-L) workers, the firing cost is R(1-L), where L is the real employment level of the firm. The firm's profit $\pi(\theta)$, given θ, in which the investment cost T has been sunk, is expressed as follows:

$$\begin{aligned} \pi(\theta) &= \theta f(L) - wL - R(1-L) \quad \textit{if} \quad L > 0, \ \textit{and} \\ \pi(\theta) &= 0 \quad \textit{if} \quad L = 0, \end{aligned} \qquad \ldots(1)$$

where $L \leq 1$ holds. Equation (1) implies that the firm has the option of dissolving itself with no output. If the firm chooses the option of dissolution, $\pi(\theta) = 0$ holds regardless of the union's resistance strategy. 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, positive employment level L, which yields a positive profit to the firm, always exists under any state $\theta \in (0, \overline{\theta}]$.

Although workers' efforts raise the possibility of good states, their efforts level has no influence on the amount of a product produced by their labor inputs. This assumption on effects of workers' efforts is not crucial to our results: even if workers' efforts yield an increase of labor inputs, our results are never influenced. If workers shirk, the firm is likely to incur a bad state. Thus, the firm's expected profit will be less than the training investment cost T: $E(\pi(\theta)|\underline{e}) < T < E(\pi(\theta)|\overline{e})$. The firm's training investment is essential to production. The training implies that the firm builds up the environment of on the job training and provides education for workers' skills formation. Hence, when the firm discovers shirking workers, the firm dismisses them.

It is costly for workers to raise the firing cost. For simplicity, the activity cost of a worker is expressed by R. However, a worker obtains a non-transferable private

benefit B from his union activity level: $B = B(R)$, $B' > 0$.[2] Consider that unions play a significant role as the 'voice system' collecting employees' claims and demands, and reporting them to firm managers. Firm managers can put the reports to practical use for increasing productivity and profit. Furthermore, the voice system of unions is profitable to workers as well as firm managers. Numerous complaints and troubles employees face in the workshop will decrease, and thus employees' motivation to do their job, and their satisfaction at work are enhanced by unions (Freeman and Medoff (1984) and Hisamoto (1993)). Non-transferable, private benefit from union activities B implies the above positive effects for workers. The function $B(R)$ is represented by figure 2: first, marginal private benefit increases with respect to R, then decreases with R. For simplicity, we assume that $\arg\max_R (B(R) - R) = 0,\ R^*$, where R^* satisfies $B'(R^*) = 1$. Note that

$$B(0) = B(R^*) - R^* = 0. \qquad ...(2)$$

Assumption (2) is weakest. If it holds that $B(R) - R < 0$ for any positive R, effect of the union disappears, and hence existence of the union is insignificant. On the other hand, if $\exists R\ B(R) - R > 0$, our conclusion of unions as commitment devices will be strengthened.

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:

$$L_U = (f')^{-1}\left(\frac{w_U - R}{\theta}\right) \quad if \quad L_U < 1$$
$$(if\ \ \theta f'(L_U) - w_U + R > 0,\ \ L_U = 1), \qquad ...(3)$$

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 if non-negative profit is realized. The non-negative profit condition is necessarily followed,

$$\pi(\theta) = \theta f(L_U) - w_U L_U - R(1 - L_U) \geq 0. \qquad ...(4)$$

Under R=0, there is an employment level which yields a positive profit by assumption of production function. However, if it holds that $\forall L_U \in (0, 1]\ \ \pi(\theta) < 0$ given R>0, the

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[2] Assumption on private benefit is frequently seen in literature on commitment devices , for example, Agihon and Bolton (1992), Dewatripont and Tirole (1994), Agihon and Tirole (1997), Dewatripont and Maskin (1995), and Qian and Xu (1998).

firm chooses L_U=0, and then $\pi = 0$.[3] For simplicity, we assume that the firm can borrow no funds. The firm cannot maintain an excess employment level under a severe state by the liquidity constraints in the financial market.

Next, consider the union's optimal resistance strategy. The union's expected utility is $w_U L_U + B(R) - R$. Given the firm's employment strategy L_U, an optimal resistance strategy is determined by

$$R = R^* \text{ or } 0 \quad \text{if} \quad R^* \leq \frac{\theta f(L_U) - w_U L_U}{1 - L_U}.$$

On the other hand, if $R^* > \frac{\theta f(L_U) - w_U L_U}{1 - L_U}$, the union chooses R=0 because it holds that $B(0) = 0 > B(R') - R'$ under $0<R'<R^*$.

Consider the case wherein positive employment level leads to negative profit under R=R^*: $\forall L_U \in (0, 1]$ $\theta f(L_U) - w_U L_U - R^*(1 - L_U) < 0$ (see figure 3). Denote the critical point as $\underline{\theta} \equiv \frac{w_U L_U + R^*(1 - L_U)}{f(L_U)}$, where employment level is the best response to R^*: $L_U = (f')^{-1}\left(\frac{w_U - R^*}{\theta}\right)$. Under $0 < \theta < \underline{\theta}$, there are two Nash equilibria: $(L_U, R) = (0, R^*)$, $\left((f')^{-1}\left(\frac{w_U}{\theta}\right), 0\right)$. The former Nash equilibrium is expressed by A, and the latter by B in figure 3. Obviously, the former Nash equilibrium A is Pareto dominated by the latter B. We assume that B, $\left((f')^{-1}\left(\frac{w_U}{\theta}\right), 0\right)$, is always implemented under $0 < \theta < \underline{\theta}$.

Next, under $\underline{\theta} \leq \theta \leq \overline{\theta}$, two Nash equilibria exist (see figure 4):

$$(L_U, R) = \left((f')^{-1}\left(\frac{w_U - R^*}{\theta}\right), R^*\right), \left((f')^{-1}\left(\frac{w_U}{\theta}\right), 0\right).$$

The former and latter are represented by A and B respectively in figure 4. We assume that, throughout this paper, the Nash equilibrium A is implemented under this case. If the Nash equilibrium B is always realized in this case, our analysis would obviously be insignificant for consideration of the roles of unions as commitment devices.

Denote the critical point of full employment under the union case as $\theta^{**} \equiv \frac{w_U - R^*}{f'(1)}$. Under $\theta^{**} \leq \theta \leq \overline{\theta}$, it holds that $L_U = 1$. It is obvious that $\underline{\theta} \leq \theta^{**}$.[4] In

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[3] The assumption that $\pi = 0$ holds if $L_U = 0$, avoids that unions resist aggressively in a severe recession, that is, huge negative profit and a high employment level occur. Hence, unions are required to choose a resistance level carefully and not to force the firm into a corner.

[4] Since (3) and (4) hold under $\theta = \underline{\theta}$, $\underline{\theta} = \frac{w_U - R^*}{f'(L_U)}$. Hence, it is obtained that $\underline{\theta} < \theta^{**}$ if $L_U(\underline{\theta}) < 1$,

summary, the following resistance and employment levels are realized as a Nash equilibrium:

$$\begin{aligned} &R=0 \quad and \quad L_U(\theta)=(f')^{-1}\left(\frac{w_U}{\theta}\right) \quad &&if \quad 0<\theta<\underline{\theta} \\ &R=R^* \quad and \quad L_U(\theta)=(f')^{-1}\left(\frac{w_U-R^*}{\theta}\right) \quad &&if \quad \underline{\theta}\le\theta<\theta^{**} \\ &R=R^* \quad and \quad L_U(\theta)=1 \quad &&if \quad \theta^{**}\le\theta<\bar{\theta}. \end{aligned} \qquad ...(5)$$

Next consider workers' expected utility and the firm's expected profit. If a worker makes efforts, his expected utility with the union is represented by

$$\begin{aligned} U_U &= \int_0^{\bar{\theta}} \{L_U(\theta)w_U + B(R) - R\}\bar{\phi}(\theta)d\theta - c \\ &= \int_0^{\underline{\theta}} L_U(\theta)w_U\bar{\phi}(\theta)d\theta \\ &\quad + \int_{\underline{\theta}}^{\theta^{**}} \{L_U(\theta)w_U + B(R^*) - R^*\}\bar{\phi}(\theta)d\theta \\ &\quad + (1-\bar{\Phi}(\theta^{**}))\{w_U + B(R^*) - R^*\} - c \end{aligned} \qquad ...(6)$$

where $\bar{\phi}(\theta)$ or $\bar{\Phi}(\theta)$ is the density or distribution function of the state when all workers have delivered efforts. Using (2) and (5), (6) is replaced by

$$\begin{aligned} U_U = &\int_0^{\underline{\theta}} (f')^{-1}\left(\frac{w_U}{\theta}\right)w_U\bar{\phi}(\theta)d\theta + \int_{\underline{\theta}}^{\theta^{**}} (f')^{-1}\left(\frac{w_U-R^*}{\theta}\right)w_U\bar{\phi}(\theta)d\theta \\ &+ (1-\bar{\Phi}(\theta^{**}))w_U - c \end{aligned} \qquad ...(6)'$$

Thus, incentive compatibility of workers under perfect information on workers' efforts is

$$U_U \ge 0, \qquad ...(7)$$

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

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

where $L_U(\theta)$ and R satisfy (5). Hence,

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and $\underline{\theta}=\theta^{**}$ if $L_U(\underline{\theta})=1$.

$$\Pi_U = \int_0^{\underline{\theta}} \left[\theta f(L_U(\theta)) - w_U L_U(\theta)\right]\bar{\phi}(\theta)d\theta$$
$$+ \int_{\underline{\theta}}^{\theta^{**}} \left[\theta f(L_U(\theta)) - w_U L_U(\theta) - R^*(1 - L_U(\theta))\right]\bar{\phi}(\theta)d\theta$$
$$+ \int_{\theta^{**}}^{\bar{\theta}} \left[\theta f(1) - w_U\right]\bar{\phi}(\theta)d\theta - T$$

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

Non-Union case

If a union is not organized, workers cannot resist the firm's dismissal policy. In this case, employment level is determined as follows,

$$L_F = (f')^{-1}\left(\frac{w_F}{\theta}\right) \quad if \quad L_F < 1$$
$$(if \quad \theta f'(L_F) - w_F > 0, \quad L_F = 1) \qquad ...(8)$$

where L_F and w_F are employment level and wage in the non-union case. In this case, if $\theta \geq \theta^* \equiv \frac{w_F}{f'(1)}$, $L_F(\theta) = 1$. Under $\theta < \theta^*$, employment level satisfies $\theta f'(L_F) - w_F = 0$.

The expected utility of workers who have made efforts is as follows:

$$U_F = \int_0^{\theta^*} w_F L_F(\theta)\bar{\phi}(\theta)d\theta + (1 - \bar{\Phi}(\theta^*))w_F - c, \qquad ...(9)$$

where U_F is denoted as a worker's expected utility without unions. Incentive compatibility is $U_F \geq 0$. ...(10)

The firm's profit is as follows,

$$\Pi_F = \int_0^{\theta^*} \left[\theta f(L_F(\theta)) - w_F L_F(\theta)\right]\bar{\phi}(\theta)d\theta + \int_{\theta^*}^{\bar{\theta}} \left[\theta f(1) - w_F\right]\bar{\phi}(\theta)d\theta - T. \qquad ...(11)$$

Since employment L_F is a decreasing function with w_F, the firm's profit decreases with w_F. Hence, (10) is always binding.

3. Perfect Information: No Moral Hazard

Lemma

[1] $w_U < w_F$

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

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

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

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

Proof

See Appendix.

Lemma indicates that full employment is more likely with unions than without unions. Lemma [2] and [3] are reasonable since unions exercise their power for job security. 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 payment is far away in the real world because it indicates that wage with unions is less than that without unions. Intuitively, it seems that the unions' bargaining power raises wage. Actually, opinions are divided on the 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; Tachibanaki and Noda (1993), Brunello (1992), Valleta (1993), Kishi (1995), and Tsuru and Rebitzer (1993).[5]

Next, compare profit of the firm without a union to that with a union. See figure 5. First, consider profit of the firm without a union. Using the envelope theorem, it holds that $\frac{\partial \pi_F}{\partial \theta} = f(L_F) > 0$ *and* $\frac{\partial^2 \pi_F}{\partial \theta^2} = f'(L_F)L_F'(\theta) > 0$ under $0 < \theta < \theta^*$. Hence, under $0 < \theta < \theta^*$, π_F is a convex function with respect to θ. Under $\theta^* \le \theta \le \bar{\theta}$, π_F is a linear function from $\frac{\partial \pi_F}{\partial \theta} = f(1) = const. > 0$. Therefore, profit of the firm without the union is represented in figure 5.

Consider the firm with the union. Under $0 < \theta < \underline{\theta}$, where the union chooses no resistance level, R=0, π_U is a convex function with respect to θ in the same manner as the case without the union. Note that $\pi_U(\theta) > \pi_F(\theta)$ under $0 < \theta < \underline{\theta}$ by lemma [1]. Clearly, the following inequalities hold:

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[5] The treat 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.

$$\begin{aligned}\pi_F(\theta) &= \theta f(L_F) - w_F L_F \\ &< \theta f(L_F) - w_U L_F \\ &< \theta f(L_U) - w_U L_U = \pi_U(\theta).\end{aligned}$$

The first inequality is introduced by $w_U < w_F$, and the second is obtained from the viewpoint that L_U is the optimal employment level of the firm given w_U. If $\theta \geq \underline{\theta}$, R=R*. When $\theta = \underline{\theta}$, $\pi_U(\underline{\theta}) = 0$ holds from the definition of $\underline{\theta}$. Under $\underline{\theta} \leq \theta < \theta^{**}$, by $\frac{\partial \pi_U}{\partial \theta} = f(L_U) > 0$ *and* $\frac{\partial^2 \pi_U}{\partial \theta^2} = f'(L_U) L_U'(\theta) > 0$, $\pi_U(\theta)$ is a convex function. Full employment is realized under $\theta^{**} \leq \theta \leq \overline{\theta}$, and thus $\pi_U(\theta)$ is linear.

Figure 5 expresses profit of the firm with the union. Note that the function $\pi_U(\theta)$ jumps at the point $\theta = \underline{\theta}$. Under $\theta^* \leq \theta \leq \overline{\theta}$, it holds that $\pi_U(\theta) > \pi_F(\theta)$ by lemma [1]. Hence, it is clear that

$$\exists \hat{\theta} \in (\underline{\theta}, \theta^*) \quad \hat{\theta} f(L_F(\hat{\theta})) - w_F L_F(\hat{\theta}) = \hat{\theta} f(L_U(\hat{\theta})) - w_U L_U(\hat{\theta}) - R^*(1 - L_U(\hat{\theta})).$$

In summary, it holds:

$$\begin{aligned} &\forall \theta \in (0, \underline{\theta}) && \pi_F < \pi_U \\ &\forall \theta \in [\underline{\theta}, \hat{\theta}) && \pi_F > \pi_U \\ &\theta = \hat{\theta} && \pi_F = \pi_U \\ &\forall \theta \in (\hat{\theta}, \overline{\theta}] && \pi_F < \pi_U \ . \end{aligned} \qquad \ldots(12)$$

From (12), existence of unions might increase expected profit. For example, consider a case of high workers' efforts cost in which the IC under the non-union case is not satisfied, but the IC under the union case is satisfied. The 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. It is unions that play a significant role in job security and increase the firm's expected profit. The union exercising power on job security enhances the firm's profit.

Proposition

There are cases wherein the expected profit of the firm with the union exceeds that of the firm without the union if workers' efforts cost c is sufficiently high: $\Pi_U > \Pi_F$.

If $\Pi_U > \Pi_F$, firms have an incentive for encouraging workers to organize unions. After wage is determined, the union's resistance strategy decreases the firm's

profit *ex post* under $\theta \in [\underline{\theta}, \overline{\theta}]$. Obviously, after observing the state, the existence of unions decreases firms' profit given the wage determined in the initial contract. This result is consistent with empirical studies: Freeman and Medoff (1984), Brunello (1992), and Becker and Olson (1992). However, unions play a significant role in job security of employees, and since unions raise employment stability, firms can lower the wage *ex ante*. Thus, keeping the previous statement on wages in mind, if unions exercise power on job security, unions would be welcomed by firms.

If the union focuses on increase of basic wage in the original contract, the union is willing to obtain the wage level to maximize the expected utility. However, the firm never wishes existence of the union since the increase of basic wage decrease the firm's profit. Since firm managers dislike strong unions, they are willing to discourage workers from organizing and managing unions. Firm managers' actions preventing union activities are generally forbidden by labor and industrial laws. However, their actions are in the gray zone in many cases. It is often difficult to verify that their actions are illegal. Hence, conflicts between unions and firms are likely, and it is difficult to establish good industrial relations. Therefore, the purpose of unions should be based on job security rather than on increasing wage.

4. Moral Hazard

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

Under asymmetric information on workers' efforts, perfect job security and a constant wage scheme induce employees to shirk. The possibility of dismissal gives an incentive to employees. No employee is willing to make efforts if there is no possibility of dismissal, that is, employees are perfectly promised their job security and a constant wage is offered. The threat of dismissal in recessions encourages workers to provide the necessary level of efforts.[6] However, the existence of unions which resist in order to keep employment level high in a recession will discourage workers from making efforts.

Suppose that the firm cannot observe workers' efforts level but can observe an imperfect signal on their efforts level. Efforts level is discrete, $e = \{\underline{e}, \overline{e}\}$, $\underline{e} < \overline{e}$. Workers' efforts cost satisfies the following condition: $C(\underline{e}) = 0$ and $C(\overline{e}) = c$. The

[6] In the efficiency wage theory, threat of dismissal is essential. See Shapiro and Stiglitz (1984).

efforts level influences the states of the firm: high efforts level provided by *all* employees enhances the occurrence of a good state. Denote density or distribution function of states in the case wherein that *all* workers have delivered high efforts level $\bar{e}$ as $\bar{\phi}(\theta)$ or $\bar{\Phi}(\theta)$. 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 $\bar{\Phi}(\theta)$ is the first order stochastic dominant to $\underline{\Phi}(\theta)$.

If all workers have made efforts, the firm receives an imperfect signal $s=\bar{s}$ with possibility q $(0.5<q<1)$ or $s=\underline{s}$ with possibility 1-q at no cost. Otherwise, even if only one worker shirks, the firm observes $s=\underline{s}$ with possibility q or $s=\bar{s}$ with possibility 1-q. Signal $\bar{s}$ $(\underline{s})$ implies imperfectly that all workers have made efforts (some workers have shirked). The firm receives signals on the workers' efforts level after workers have chosen their actions, i.e. making efforts or shirking, and then the firm decides whether to invest for skills formation or not. If the firm chooses no investment, labor inputs are nullified, and hence no one is employed by the firm: L=0. In this case, zero profit is realized. On the other hand, if the training investments are done, Nature chooses the state observable by workers and the firm. See figure 6 on timing of decisions by workers and the firm.

When the firm receives a high signal $\bar{s}$, using Bayse's rule, the conditional probability whereby all workers have made efforts is q. If $s=\underline{s}$, the conditional probability is 1-q. When the firm receives the high signal $\bar{s}$, the expected profit is $qE(\pi(\theta)|\bar{e})+(1-q)E(\pi(\theta)|\underline{e})-T$. On the other hand, if $s=\underline{s}$, $qE(\pi(\theta)|\underline{e})+(1-q)E(\pi(\theta)|\bar{e})-T$. Furthermore, the following condition is assumed:

$$qE(\pi(\theta)|\underline{e})+(1-q)E(\pi(\theta)|\bar{e})<T<qE(\pi(\theta)|\bar{e})+(1-q)E(\pi(\theta)|\underline{e}). \quad ...(13)$$

Inequality (13) indicates that, if the firm faces a bad signal, the firm will have no incentive to invest for skills formation. Hence, when the firm receives a bad signal, the firm would choose to make no investment and to hire no employees.

We assume that contracts contingent on imperfect signals cannot be made by contractual incompleteness. When the signal is not imperfect well, the firm will determine worker dismissal based on the signal. If the firm receives the high signal $\bar{s}$, the firm continues employing workers and producing. Otherwise, the firm is unwilling to start producing, the firm produces no output and employees receive nothing, L=0. In this case, workers' incentive compatibility with the union is as follows:

$$\begin{aligned} U_U &\equiv q\int_0^{\bar{\theta}}\left\{w_U L_U(\theta)+B(R)-R\right\}\bar{\phi}(\theta)d\theta-c \\ &\geq (1-q)\int_0^{\bar{\theta}}\left\{w_U L_U(\theta)+B(R)-R\right\}\underline{\phi}(\theta)d\theta \end{aligned} \quad ...(14)$$

Using (2), the incentive compatibility (14) is replaced by

$$I_U(w_U) \equiv \int_0^{\bar{\theta}} w_U L_U(\theta)\left\{q\bar{\phi}(\theta) - (1-q)\underline{\phi}(\theta)\right\}d\theta \geq c. \qquad ...(14)'$$

In the same manner, incentive compatibility without the union is considered,

$$U_F \equiv q\int_0^{\bar{\theta}} w_F L_F(\theta)\bar{\phi}(\theta)d\theta - c \geq (1-q)\int_0^{\bar{\theta}} w_F L_F(\theta)\underline{\phi}(\theta)d\theta. \qquad ...(15)$$

Then, it holds that

$$I_F(w_F) \equiv \int_0^{\bar{\theta}} w_F L_F(\theta)\left\{q\bar{\phi}(\theta) - (1-q)\underline{\phi}(\theta)\right\}d\theta \geq c. \qquad ..(15)'$$

Obviously, it holds that $L_U(\theta) > L_F(\theta)$ under $\theta \in [\underline{\theta}, \theta^*]$ if $w_U = w_F = w$ (see proof of lemma). However, the distribution function of the state contingent on efforts level and the production function influence the levels of $I_U(w)$ and $I_F(w)$. Hence, the sign of $I_U(w) - I_F(w)$ is ambiguous although the incentive compatibility (14)' and (15)' are binding on the equilibrium. 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 wherein the union is welcomed by the firm. 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 $w_U < w_F$.[7] We can show that profit of the firm with the union is less than that without the union for any state if $w_U > w_F$. Clearly, the following inequalities hold:

$$\begin{aligned}
\pi_U(\theta) &\equiv \theta f(L_U) - w_U L_U - R(1-L_U) \qquad R = 0 \ or \ R^* \\
&\leq \theta f(L_U) - w_U L_U \\
&< \theta f(L_U) - w_F L_U \qquad (\because w_U > w_F) \\
&< \theta f(L_F) - w_F L_F \equiv \pi_F(\theta).
\end{aligned}$$

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.

An example

We can show a simple example of $w_U > w_F$ under asymmetric information on workers' actions. Two states, boom and recession, exist: $\bar{\theta} > \underline{\theta} > 0$. If all workers make efforts, the probability of boom or recession is 0.5. On the other hand, recession always occurs if some workers shirk. The effort cost is denoted as c. From a viewpoint of backward induction consideration, consider the determinant of employment level given wage level after the state is observed. In the union case, for simplicity, the following

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

inequalities are assumed:

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

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

$$L_U = 1 \quad if \ \theta = \overline{\theta}$$
$$L_U = L_U^* \quad if \ \theta = \underline{\theta} \qquad ...(16)$$

where it is satisfied that $\underline{\theta} f'(L_U^*) - w_U + R^* = 0$ and $\underline{\theta} f(L_U^*) - w_U L_U^* - R^*(1 - L_U^*) \geq 0$.

Incentive compatibility is represented by

$$U_U = \frac{q}{2} w_U (1 + L_U^*) - c \geq (1-q) w_U L_U^*, \qquad ...(17)$$

where the reservation wage is zero in the same manner as the previous chapter. Hence, (17) is replaced as follows:

$$w_U \left\{ \frac{q}{2} + \left(\frac{3q}{2} - 1 \right) L_U^* \right\} \geq c. \qquad ...(17)'$$

Next, consider the non-union case. The following assumption holds:

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

Thus, it holds that

$$L_F = 1 \quad if \ \theta = \overline{\theta}$$
$$L_F = L_F^* \quad if \ \theta = \underline{\theta} \qquad ...(18)$$

where L_F^* satisfies $\underline{\theta} f'(L_F^*) - w_F = 0$. Without unions, incentive compatibility is

$$w_F \left\{ \frac{q}{2} + \left(\frac{3q}{2} - 1 \right) L_F^* \right\} \geq c. \qquad ...(19)$$

Note that (17)' and (19) are always binding on the equilibrium. If $q \geq \frac{2}{3}$, the left hands of (17)' and (19) are positive. If $q < \frac{2}{3}$, the left hands of (17)' and (19) 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 (17)' or (19) 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, suppose that w_U and w_F are equal. Under w_U=w_F=w, existence of unions leads to high job security: $L_U^* > L_F^*$. Hence, if $q > \frac{2}{3}$, it holds that

$$w \left\{ \frac{q}{2} + \left(\frac{3q}{2} - 1 \right) L_U^* \right\} > w \left\{ \frac{q}{2} + \left(\frac{3q}{2} - 1 \right) L_F^* \right\}. \qquad ...(20)$$

Since (17)' and (19) are always binding, it is obtained that $w_U < w_F$. This result is similar to the previous results under perfect information on workers' activities.

However, if $q < \frac{2}{3}$, (21) holds instead of (20) by $L_U^* > L_F^*$:

$$w\left\{\frac{q}{2}+\left(\frac{3q}{2}-1\right)L_F^*\right\} > w\left\{\frac{q}{2}+\left(\frac{3q}{2}-1\right)L_U^*\right\}. \quad \text{...(21)}$$

In this case, (21) leads to $w_F < w_U$. 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 very imperfect, that is, it is difficult for the firm to know whether all the workers have delivered efforts or not, it holds that $w_F < w_U$. A high wage induces workers to make efforts and prevents moral hazard since unions give employees high job security. Without unions, workers have less job security, and hence they have incentives for making efforts while they get a lower wage. High job security by unions and a high payment from the incentive problem decrease the profits of firms. Therefore, firms are unlikely to wish for the existence of unions.

5. Discussion: Blue Collar and White Collar

We have considered the role of unions as commitment devices. It is shown that unions are more likely to play a significant role as commitment devices under symmetric information than under asymmetric information. 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. It is difficult for the firm managers to distinguish if white collar workers have made efforts. Furthermore, the cost of measuring cost of white collar workers' skills is higher than the cost for blue collar workers. Actually, as Koike (1997) points out, both white collar workers and blue 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. Therefore, the moral hazard problem is more likely to occur at the workshops of white collar workers rather than those of blue collar workers.

Existence of moral hazard lowers the role of unions as commitment devices. 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. This is a hypothesis to the question of why white collar workers are less likely to organize unions than blue collar workers.

6. Conclusion

There is a positive view on unions which applies the 'Exit and Voice' approach of Hirschman (1970). Unions play various significant roles as a voice system for constructing good industrial relations. Unions can collect employees' claims and demands, and report them to the firms' managers at a low cost. Firms then put the unions' reports to practical use for increasing productivity and profit. The voice system of unions is thus valuable for firms.

However, this view has a weak point. Firm managers can also institute adequate systems of communication and decision making between managers and workers without the constraints imposed by collective bargaining. Hence, there should be other roles for unions besides the voice system. 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 a recession. Firms always optimize employment level *ex post*. However, if unions exercise their power in relation to job security, firms can promise to keep employment level high as a result of the unions' role as a commitment device.

Furthermore, we extend the model to asymmetric information on employees' actions and show that the existence of information asymmetry may break the role of unions as commitment devices. Perfect certainty on job security discourages workers from making efforts. Uncertainty on job security, that is, the possibility of dismissal, encourages workers to make efforts. Hence, since unions keep job security high, the moral hazard problem is likely to occur. Existence of unions weakens the workers' incentive scheme. The result explains the observed fact wherein 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, a firm managers cannot distinguish whether white collar workers have made appropriate efforts. The firm's managers do not wish for the existence of a union under moral hazard and will hinder the union members and prevent the union's activities. Hence, workers are discouraged from organizing, managing, and participating in unions. The result indicates

that white collar workers are less likely to manage and participate in unions than blue collar workers, which is consistent with empirical studies.

Appendix

Proof of lemma

[1]Suppose that $w_U = w_F = w$. Under $0 < \theta < \underline{\theta}$, it holds that $L_U(\theta) = L_F(\theta) = (f')^{-1}\left(\frac{w}{\theta}\right)$. Furthermore, $\theta^* \equiv \frac{w}{f'(1)} > \theta^{**} \equiv \frac{w - R^*}{f'(1)}$ holds. Hence, it is realized that $L_U = L_F = 1$ under $\theta^* \le \theta \le \overline{\theta}$ and $L_U = 1 > L_F$ under $\theta^{**} \le \theta < \theta^*$. Finally, consider the case under $\underline{\theta} \le \theta < \theta^{**}$. In this case, it is obtained that $L_U(\theta) = (f')^{-1}\left(\frac{w - R^*}{\theta}\right) > L_F(\theta) = (f')^{-1}\left(\frac{w}{\theta}\right)$. Hence, employment level for any state with the union is higher than that without the union, and thereby it holds that $U_U(w) > U_F(w)$. If $w \le \overline{w}$, 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 firm are enforceable, it holds that $\frac{dU_U}{dw_U} \ge 0$ at the minimum solution w_U of $U_U = 0$, and when $U_F < 0$ (See figure A-1). Since the firm maximizes its profit, it chooses the minimum wage that satisfies the incentive compatibility. 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 $\theta^* \le \theta \le \overline{\theta}$, $L_U = L_F = 1$. it holds that $L_U(\theta) = 1 > L_F(\theta)$ under $\theta^{**} \le \theta < \theta^*$. Under $\underline{\theta} \le \theta < \theta^{**}$, using [1], it is obtained that $L_U = (f')^{-1}\left(\frac{w_U - R^*}{\theta}\right) > L_F = (f')^{-1}\left(\frac{w_F}{\theta}\right)$. In the same manner, under $0 < \theta < \underline{\theta}$, $L_U(\theta) > L_F(\theta)$ by $w_U < w_F$.■

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Timing

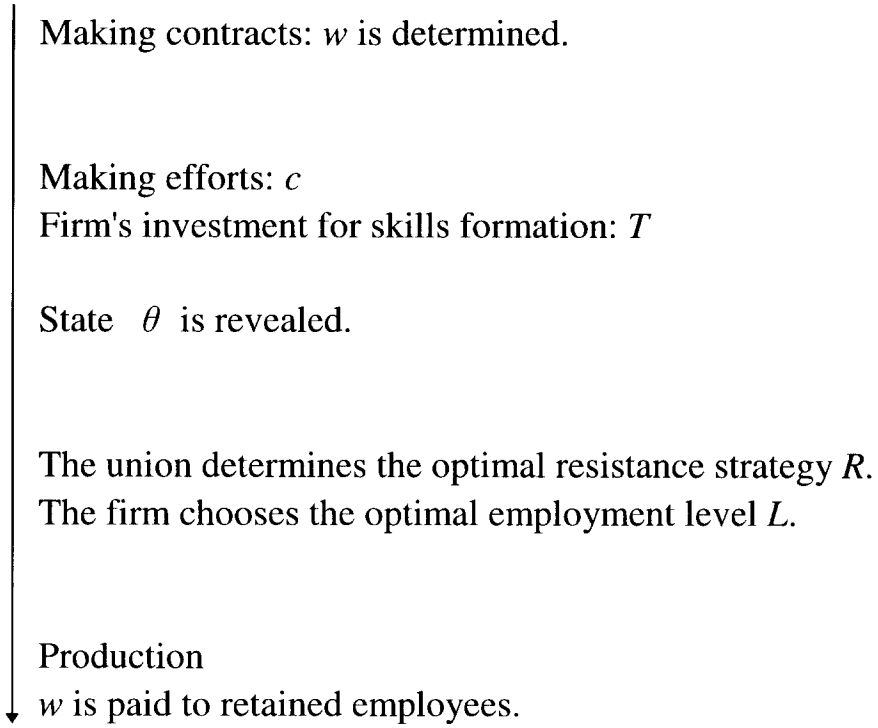

Figure 1

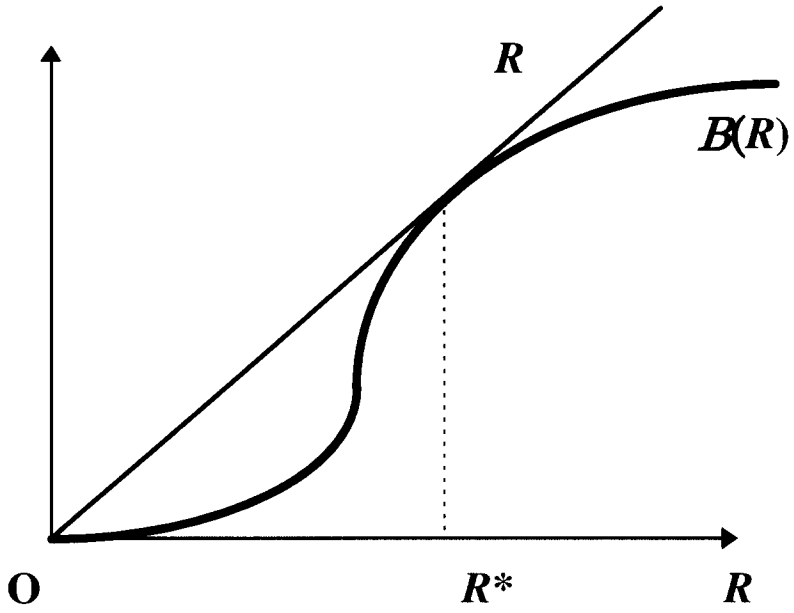

Figure 2

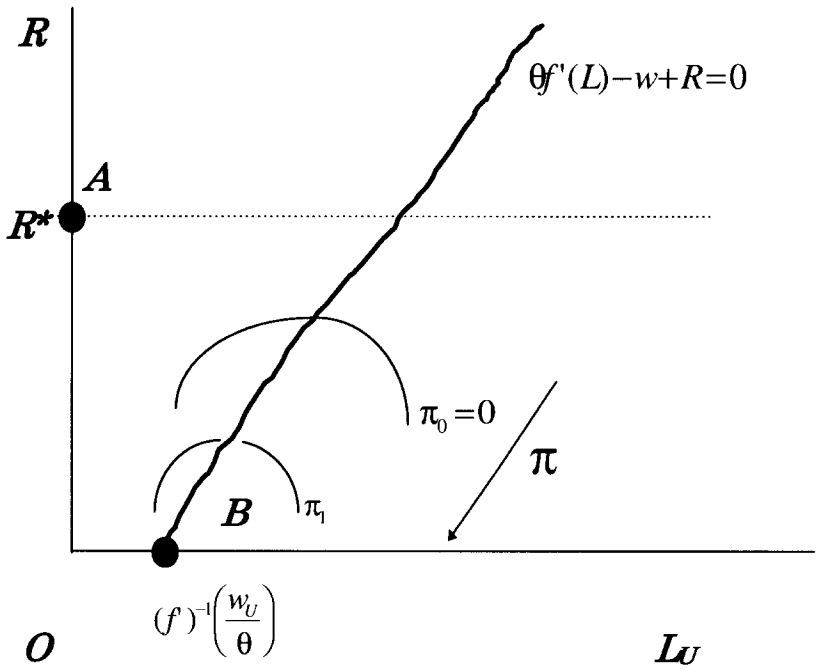

Figure 3

π_0 *and* π_1 are iso-profit curves: $\pi_1 > \pi_0 = 0$.

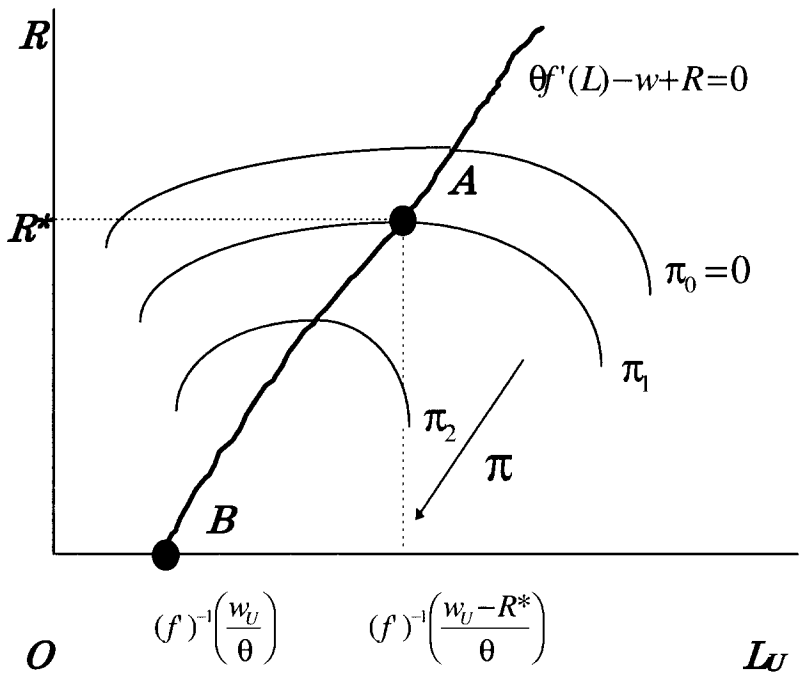

Figure 4

π_0, π_1 *and* π_2 are iso-profit curves: $\pi_2 > \pi_1 > \pi_0 = 0$.

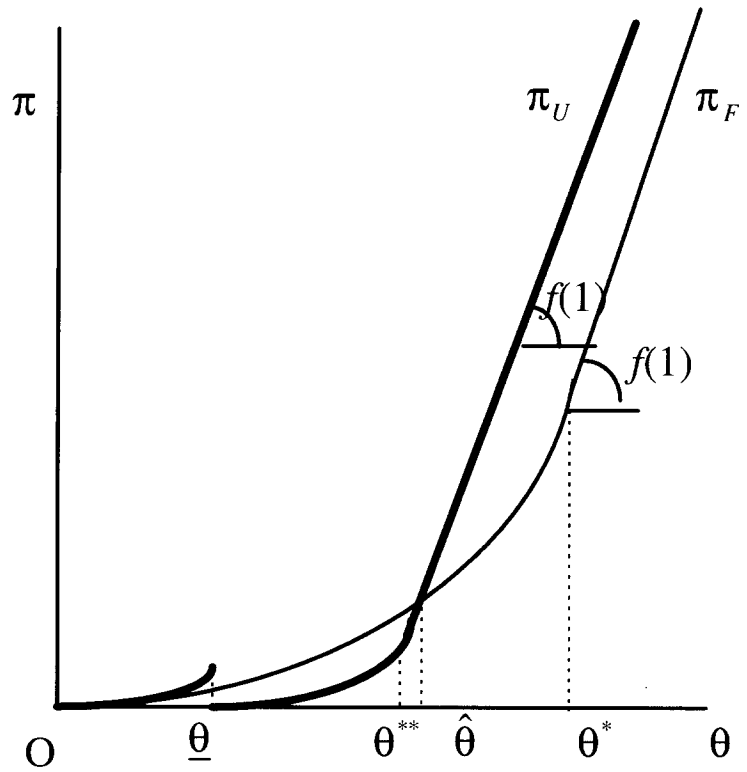

Figure 5

Timing

Making contracts: w is determined.

Making efforts: c
Firm's receiving signal: s

Firm's investment for skills formation: T

State θ is revealed.

The union determines the optimal resistance strategy R.
The firm chooses the optimal employment level L.

Production
w is paid to retained employees.

Figure 6

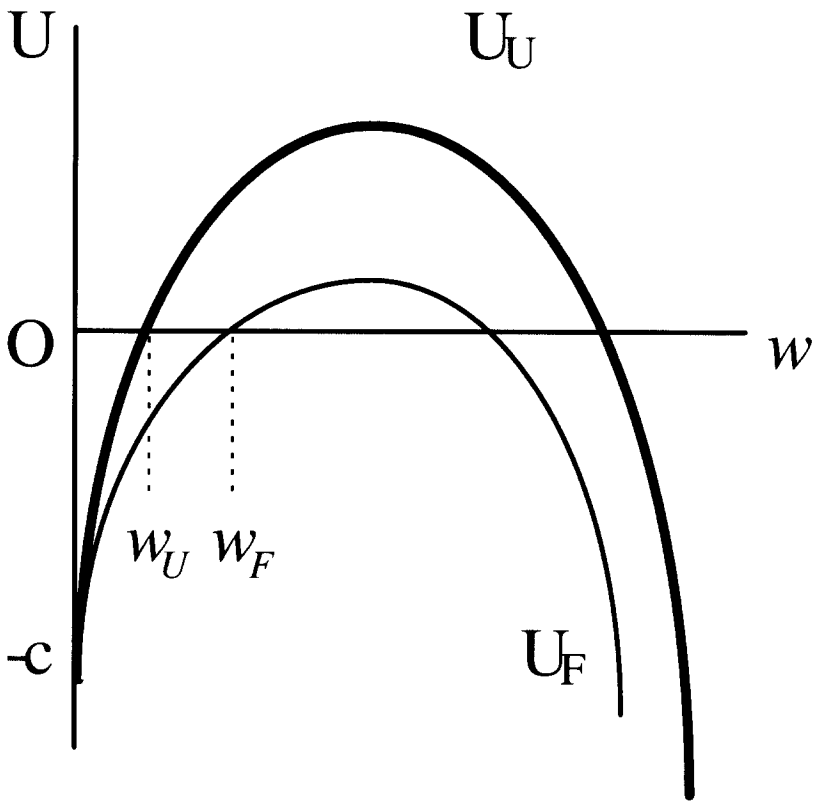

Figure A-1

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.