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Abstract

Under incompleteness of contracts, we consider one role of unions to be as a commitment device. When wage and dismissal rate contingent on the states are not described in labor contracts, although a wage offer is verifiable, the firm cannot promise to keep employment *ex ante* and cannot make employees believe the promise of job security. Thus, the firm must offer a high wage to encourage workers in accumulating skills. However, if strong unions exist and resist the firm's dismissal policy, unions can play a significant role as commitment devices for job security. Then, since the firm can decrease wage and increase employment level, we can expect the profit of the firm with the strong union to be more than that without a union. Therefore, strong unions would be welcome. Furthermore, we consider the possibility of wage adjustment as renegotiation in a recession, and show that wage adjustment occurs in slightly severe recessions, but that under severe recessions dismissal of employees cannot be avoided.

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I . Introduction

Organizing unions and collective bargaining have been established and spread as a universal right of workers all over the world during the twentieth century, which is described explicitly in labor laws. This implies that workers can organize unions even if a firm does not wish for the existence of a union. Indeed, we have experienced many conflicts between unions and firms resulting in damage to both the firms and the workers due to the insistence of opinions and hard fought battles. From this, you may think that firms would never wish to face strong unions.

The above argument presupposes that the existence of unions is based solely on the right of workers, and that firms are forced to allow the organization of unions and collective bargaining which decrease firms' profits. We believe, however, that there are different foundations for the existence of unions besides the right of workers. If the right of workers is the only reason unions exist, then numerous unions would not be organized, not only because the huge cost of organizing and managing unions is borne by the workers, but also because firms discourage workers from organizing and participating in unions. The purpose of this paper is to consider these different foundations. If there are other positive aspects of unions, firms might have incentives for encouraging employees to organize unions, even if strong unions exercise their bargaining power.

Unions are typically viewed negatively when they exercise their strong bargaining power and lead to inefficient allocation of labor. On the other hand, one positive view applies the 'Exit and Voice' approach of Hirschman (1970) to unions. Unions play various significant roles as the voice system for constructing good industrial relations. A union can collect employees' claims and demands, and report them to the firm's managers. The firm then puts the union's reports to practical use increasing productivity and profit. The voice system of a union is thus valuable for the firm. Freeman and Meddof (1984) investigated this role of unions.

However, this view has a weak point. A firm's 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 of unions besides the voice system. In this paper, we will provide a new role of unions focusing on a union's bargaining power. A union's bargaining power can play a substantial role as a commitment device under contractual incompleteness. In the real world, contracts are apt to be incomplete due to bounded rationality or huge cost. Under contractual incompleteness, a firm 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 a firm can promise to keep a high employment level as a result of the union's role as a commitment device.

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 not willing to pay the wage, and the firm is not punished in court because of unverifiability. Hence, as labor laws state, basic wage is verifiable and described explicitly in labor contracts. However, workers face uncertainty in job security. The firm can dismiss employees under some restrictions determined by labor laws. Actually, dismissal of employees contingent on the states cannot be described or determined *ex ante* in labor contracts due to bounded rationality or huge cost. Therefore, complete contracts contingent on the firm's states cannot be made. 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 for skill accumulation, 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 at accumulating skills unless a sufficiently high wage is offered.

What effects do unions have on firms' behavior? If a union exercises strong power and tries to keep employment at a desirable level for the 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, strong unions might be welcomed by firms because unions act as a commitment device. Indeed, as Koike (1977) and Aoki (1988) mention, while some unions have exercised 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 Muroran Steel Mill of Nihon Seiko resisted a dismissal policy violently 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 in Japan that attempts to dismiss employees can bring a union's resistance.

Although we consider the union's role in job security, the union might also exercise power to increase wages. There are many studies on bargaining theory and unions' strike activity, for example, Hayse (1984), Tracy (1987), Hart (1989), Kennan (1986), and Gu and Kuhn (1998). In the real world, unions negotiate with firms managers to increase wages, and conflicts between unions and firms often occur. Consider the case wherein a union, after producing outputs, exercises its power to extract a firm's profits beyond the verifiable basic wage. Obviously, the stronger the union, the less profit for the firm. Hence, if unions exercise strong power to extract from the pie, firms would never want a strong union, making attacks on the union likely in order to weaken their power. Actually, union membership rate is rapidly decreasing in the U.S. Freeman and Medoff (1984) and Blanchflower and Freeman (1992) point out that offense of firms to unions, which would be caused by unions' effects of increasing wage level, leads to decreasing the membership rate. Therefore, we will conclude that unions should try to keep job security higher rather than to increase wage for constructing good industrial relationship.

The incomplete contract approach has been used since Grossman and Hart (1986), and Hart and Moore (1988) (1990). Recent studies consider commitment devices under the 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 (Deatripont 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.

Under incomplete contracts, renegotiation may improve the welfare of the firm and the union after Nature has chosen the state. We consider wage adjustment as renegotiation. If renegotiation does not occur, rent of employees depends on the wage determined by the original contract and the union's resistance policy. However, the firm may be able to compensate for the rent by offering a new wage. Although the new wage would be lower than the original wage, the lower wage would implement an increase in the employment level. Hence, workers maintain the same level of the rent, and the firm increases its profit. We will show that wage adjustment occurs in slightly severe recessions, but that under severe recessions dismissal of employees cannot be avoided.

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. We will show that unions play a significant role as commitment devices, and that the expected profit of the firm with a strong union can be more than that of the firm without a union. Chapter 4 focuses on the case wherein unions are tough negotiators on bonus payment bargaining. In this case, firms do not wish for the existence of unions since unions extract most of the firms' profits. In chapter 5, we consider the possibility of renegotiation. It is shown that wage adjustment as renegotiation increases the firm's profit. Finally, our conclusions are set forth in chapter 6.

Ⅱ. Existence of Unions

In this paper, we intentionally consider a strong union. Intuitively, it is thought that when a firm faces a strong union, profit is small due to the union exercising its bargaining power. As McDonald and Solow (1981) show, the stronger the union's power, the smaller the firm's profit. However, under incompleteness of contracts, as we demonstrate later, existence of a strong union gives the firm the opportunity and circumstance of a commitment to job security so that the firm with the strong union might increase its expected profit.

As an origin of the union's power, there is an advantage to collecting information on the current state of the firm. Without correct and precise information, the union cannot be effective even if the union is a tough negotiator. In this model we assume that the union has perfect information on the state of the firm. No asymmetric information exists. Indeed, various laws of industrial relations encourage workers and/or force firms to organize unions, and allow the unions to have bargaining power. In many countries, firms are required to report to, and negotiate with unions on important matters for workers, such as dismissal, wage adjustment, and job rotation before the firms perform these actions. The legislation forces a firm to give information on its management and its economic state to the union. Furthermore, organizing unions decreases the cost of information transfer among workers. Without unions, each employee would owe a huge cost for consideration among the employees, a voice in decisions, and performance of strategy, thereby making employees unwilling to resist the firm. On the other hand, unions play the role of hubs in collecting information and decision making. The larger the firm, the more effective will the union be as a hub. Thus, unions have a significant role in collecting information and promoting group activities.

Hence, workers can know the state of the firm and perform the proper resistance policy in organizing its union.

We focus on a union's resistance policy to dismissal by a firm. As we mention later, after wage has been decided, both the union and the firm observe the state. The firm might dismiss some employees to maximize its profit sweeping out an excess of workers. On the other hand, the union can raise the firm's dismissal cost, for example, by accusations through the mass media of 'unfair' dismissals, demonstrations and sit-ins. These actions by the union affect the dismissal policy of the firm. Denote pressure of the union's resistance as R, which is the firing cost of one employee. The union chooses the level of R for every employment level at no cost, $R \in [0, \overline{R}]$. If the firm dismisses $(N\text{-}L)$ workers, the firing cost is $R(N\text{-}L)$, where N is a labor pool in the firm and L is the real employment level of the firm. Although to have no cost for resistance is quite unusual, it is assumed here because we want to focus on a strong union. If the cost is high, the union's activities are constrained. The cost of the union's activities is not zero in the real world, but we wish to consider the case wherein the cost is sufficiently low and the union is active.[1]

Although wage bargaining between unions and firms is important, for simplicity do not consider it, allowing its effect to be seen more easily. We mention this effect later. In addition, the threat of entry by rival firms prevents unions from raising wages. If rival firms enter the market and the industry, 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.

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

① First, the firm has a labor pool N normalized to 1 and offers wage w to workers, when wage w is not yet paid. The firm cannot make contracts contingent on the states with any worker or the union. This wage offer is verifiable.

② Workers are required to train for skills which are essential to labor inputs. The training cost c is a constant. If they have finished training, each of them supplies one labor input unit. Otherwise, they supply no labor input, i.e., produce nothing. Furthermore, it is assumed that whether workers are shirking or not is verifiable and recognized by the firm. If they are shirking, these workers are dismissed because of perfect information on workers' efforts.

③ Then, Nature chooses a state, and the firm and the union know the realized state $\theta \in (0, \overline{\theta}]$.

④ The union chooses the optimal resistance policy for every employment level after observing the state. The union can commit the resistance policy before the

employment level is determined. The resistance policy is observed by the firm, also. Under the state, the firm optimizes employment level while the firm faces resistance policy of the union.

⑤ If dismissal occurs, dismissed workers receive no payment. On the other hand, employees retained by the firm receive the wage determined by the original contract.

In this model, there are three main factors to the union's strong power: [1]the union can observe the real state as perfectly as the firm; [2]the union can commit resistance policy before determining employment level set by the firm; [3]resistance policy of the union is at no cost. Since we have mentioned [1] and [3] previously, let's consider [2]. The commitment assumption implies that the resistance policy of the union must be discussed and recognized in the general meeting or the standing committee. Unless the resistance policy is submitted to the general meeting or the standing committee, the union cannot change the policy. The assumption means decision making in the union based on the democratic way. Furthermore, there is another reason. A union of a large firm has very numerous workers, then it takes huge costs and long time on the decision making process. Hence, once the union has determined the strategy through the proper democratic way, the members of the union cannot easily change the position and strategy. On the other hand, number of managers is much less than that of employees. The managers can always have the executive meeting to determine and change their policy.

Intuitively, you might think that a union with these origins of power decrease a firm's profit. However, we will show that a very strong union like this is welcomed by the firm. Because existence of the union provides employees with high job security, the firm with the union can guarantee to keep employment *ex ante* through resistance of the union, i.e., the union plays a significant role as a commitment device of the firm for job security.

After observing the realized state, the union and the firm have an incentive for renegotiation. Because wage is determined *ex ante*, renegotiation may be Pareto improving. Renegotiation is considered later.

We assume that the purpose of the union is to maximize the expected wage. After the union observes the state, the union determines resistance policy R for every employment level to maximize the employment level given w and θ. R is represented as a function of θ and L, $R = R(\theta, L)$. The firm's profit maximization problem given θ and R is expressed as follows:

$$\underset{L}{Max}\ \pi(\theta, L) = \theta f(L) - wL - R(\theta, L)(1-L) \quad if \quad L > 0$$
$$\pi(\theta, 0) = 0 \qquad , \qquad ...(1)$$
$$s.t.\ L \le 1$$

where $R(\cdot)(1-L)$ is dismissal cost.

Furthermore, we assume that the firm can borrow no funds. If the firm maintains an excess employment level under a severe state and a negative profit is realized, the firm goes bankrupt. Hence, the firm is forced to dismiss some employees, and a non-negative profit is realized under the union's resistance policy R. Here, consider the case whereby negative profit is realized under the union's resistance policy, which occurs if the union is irrational and performs its resistance policy in order to do damage to the firm. In this case, knowing the resistance policy, the firm managers are not willing to produce outputs. If the firm manages to produce outputs, negative profit is realized and the firm goes bankrupt. After all, the firm is dissolved before outputs are produced: $L = 0$ *and* $\Pi = 0$. This implies that the firm has an option to avoid negative profit level regardless of the resistance policy of the union. Thus, workers receive no payment without the supply of labor input. Hence, the rational union is not willing to force the firm into a corner.

It is assumed that the production function $f(L)$ satisfies the following condition:
$f' > 0,\ f'' < 0,\ f(0) = 0$ and $\lim_{L \to 0} f'(L) = +\infty$. ...(2)

This assumption implies that positive employment level L always exists for any state $\theta \in (0, \bar{\theta}]$.

1. No dismissal case

We consider the stage after the state is revealed from a view of backward induction consideration. In this stage, wage is given. First, consider the case wherein the firm can maintain full employment of all its workers, that is $\pi(\theta, 1) = \theta f(1) - w_U \ge 0$, where w_U denotes wage under existence of the union. In this case, the firm can pay the contract determined wage to all workers. Denote the critical point as $\theta^{**} \equiv \dfrac{w_U}{f(1)}$, and thereby this case is $\theta \ge \theta^{**}$.

If it holds that $\theta f'(1) - w_U \ge 0$, that is, a boom occurs, the firm is willing to employ all workers regardless of resistance of the union. No conflict occurs under $\theta \ge \theta_U^* \equiv \dfrac{w_U}{f'(1)}$ between the firm and the union. However, if the union does not resist under $\theta^{**} \le \theta < \theta_U^*$, i.e., R=0 for any employment level, some workers will be dismissed. Thus, the union determines resistance policy $R(\theta, L_U)$ for job security:

$$\forall\theta \in [\theta^{**}, \theta_U^*) \quad \forall L_U \in [0, 1) \quad R(\theta, L_U) = \frac{\theta f(L_U) - w_U L_U}{1 - L_U},$$
$$and \quad R(\theta, 1) = 0$$

where L_U is employees in the firm with the union. When the union has strong power and $\overline{R}$ is sufficiently high, the firm is forced to keep employing all workers. To sum up, the union's policy is

$$\forall\theta \in [\theta^{**}, \overline{\theta}] \quad \forall L_U \in [0, 1) \quad R(\theta, L_U) = \frac{\theta f(L_U) - w_U L_U}{1 - L_U}.$$
$$and \quad R(\theta, 1) = 0$$

If the firm maintains full employment L_U=1, then the union's utility is maximized. Hence, it holds that $\forall\theta \in [\theta^{**}, \overline{\theta}] \quad L_U(\theta) = 1$. If the firm employs workers at less than 1, its profit is zero and lower than that under full employment.

2. Dismissal case

Next consider a severe recession when the firm cannot maintain full employment. In other words, if the firm dismisses no employees, the firm's profit is negative. Concretely, $\pi(\theta, 1) = \theta f(1) - w_U < 0$, that is $\theta < \theta^{**}$. In this case, it is optimal for the union to choose the following resistance policy R:

$$\forall\theta \in (0, \theta^{**}) \quad R(\theta, L_U) = \begin{cases} 0 & if \quad L_U \geq L_U^{**}(\theta) \\ \dfrac{\theta f(L_U) - w_U L_U}{1 - L_U} & if \quad L_U < L_U^{**}(\theta), \end{cases}$$

where $L_U^{**}(\theta)$ (< 1) is the employment level under the state θ satisfying $\theta f(L_U) - w_U L_U = 0$. ...(3)

If the firm employs more than $L_U^{**}(\theta)$, a negative profit is realized. If $L_U \leq L_U^{**}(\theta)$, then zero profit is realized under the union policy. It is optimal for the firm to employ $L_U^{**}(\theta)$ under the state θ since the outcome is indifferent for the firm at any employment level less than $L_U^{**}(\theta)$.

In summary, employment level is realized as follows:

$$L_U(\theta)=\begin{cases} 1 & if \quad \theta \geq \theta^{**} \\ L_U^{**}(\theta) & if \quad \theta < \theta^{**}. \end{cases} \qquad ...(4)$$

It is clear that $L_U^{**}(\theta)$ increases with the state under $0<\theta\leq\theta^{**}$.

A worker's expected utility with the union is represented as follows:

$$U_U=\int_0^{\bar{\theta}}\left[L_U(\theta)w_U+(1-L_U(\theta))\overline{w}\right]\phi(\theta)d\theta-c$$

$$=\int_0^{\theta^{**}}\left[L_U^{**}(\theta)w_U+(1-L_U^{**}(\theta))\overline{w}\right]\phi(\theta)d\theta+(1-F(\theta^{**}))w_U-c,$$

where $\phi(\theta)$ or $F(\theta)$ is the density or distribution function of the state. Thus, from perfect information on workers' skill accumulation, incentive compatibility of workers is

$$U_U\geq\overline{w}, \qquad ...(5)$$

where $\overline{w}(\geq 0)$ is the reservation wage. The firm's expected profit with the union is

$$\Pi_U\equiv\int_0^{\bar{\theta}}\pi_U(\theta)\phi(\theta)d\theta$$

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

Using equation (3),

$$\Pi_U=\int_{\theta^{**}}^{\bar{\theta}}\left[\theta f(1)-w_U\right]\phi(\theta)d\theta. \qquad ...(6)$$

It is clear that the firm's profit is a decreasing function of w_U. Thereby, the incentive compatibility (5) is always binding.

3. Non-Union case

If a union is not organized, workers cannot resist the firm's dismissal policy. L_F and w_F are employment level and wage in the non-union case. In this case, employment level is determined as follows:

$$\begin{aligned} &\theta f'(L_F)-w_F=0, \quad L_F\leq 1 \\ &\quad (if \quad \theta f'(L_F)-w_F>0, \quad L_F=1). \end{aligned} \qquad ...(7)$$

and

$$L_F(\theta)=\begin{cases} 1 & if \quad \theta \geq \theta^{*} \\ L_F^{*}(\theta) & if \quad \theta < \theta^{*}. \end{cases} \qquad ...(8)$$

where $\theta^{*}\equiv\frac{w_F}{f'(1)}$, *and* $L_F^{*}(\theta)$ (<1) is the employment level under the state θ satisfying $\theta f'(L_F)-w_F=0$. Using (8), the expected utility of workers is as follows:

$$U_F=\int_0^{\theta^{*}}\left[w_F L_F^{*}(\theta)+\overline{w}(1-L_F^{*}(\theta))\right]\phi(\theta)d\theta+(1-F(\theta^{*}))w_F-c, \qquad ...(9)$$

where U_F denotes a worker's expected utility without unions. Incentive compatibility is $U_F \geq \overline{w}$. ...(10)

The firm's profit is as follows:

$$\Pi_F \equiv \int_0^{\bar{\theta}} \pi_F(\theta)\phi(\theta)d\theta = \int_0^{\bar{\theta}} \left[\theta f(L_F(\theta)) - w_F L_F(\theta)\right]\phi(\theta)d\theta .$$

In the same manner,

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

Since employment L_F is a decreasing function of w_F, the firm's profit decreases with w_F. Hence, incentive compatibility (10) is always binding, and w_F is offered to satisfy $U_F = \overline{w}$.

Ⅲ. Unions as Commitment Devices

1. A Benchmark Analysis: Full Commitment Case

Before considering the commitment device role of unions, a benchmark analysis under complete contract, i.e., full commitment case, is useful. Suppose that the firm can make contracts contingent on the states. Thus, both wages and employment levels contingent on the states are determined *ex ante*: $w(\theta)$ *and* $L(\theta)$. Since it is perfect information obtained on workers' skill accumulation, the incentive compatibility under the complete contract is expressed as follows,

$$U_C \equiv \int_0^{\bar{\theta}} \left(w_C(\theta)L_C(\theta) + (1 - L_C(\theta))\overline{w}\right)\phi(\theta)d\theta - c \geq \overline{w},$$

where U_C , w_C, and L_C represent workers' expected utility, wage, and employment level under the full commitment case. The firm's profit is $\Pi_C \equiv \int_0^{\bar{\theta}} \left[\theta f(L_C(\theta)) - w_C(\theta)L_C(\theta)\right]\phi(\theta)d\theta$.

Solving this full commitment problem,

$$\theta_C \equiv \frac{\overline{w}}{f'(1)}$$

$$\begin{aligned} &\forall\theta \in [\theta_C, \bar{\theta}] \quad L_C(\theta) = 1 \\ &\forall\theta \in (0, \theta_C) \quad L_C(\theta) = L_C^*(\theta) \end{aligned} \quad , \quad ...(12)$$

where $L_C^*(\theta)$ is the employment level under the state θ satisfying $\theta f'(L_C(\theta)) - \overline{w} = 0$. ...(13)

Wages contingent on the states are determined by

$$U_C \equiv \int_0^{\theta_C} \left(w_C(\theta)L_C^*(\theta) + (1 - L_C^*(\theta))\overline{w}\right)\phi(\theta)d\theta + \int_{\theta_C}^{\bar{\theta}} w_C(\theta)\phi(\theta)d\theta - c = \overline{w} \quad \ldots(14)$$

Note that the wage schedule contingent on the states is ambiguous because workers' utility for wage is linear. Thus only total expected wage is determined.

As (13) implies, employment level is efficient in any state. This result is obtained with perfect information, no risk problem, and full commitment. If $\overline{w} = 0$, full employment is always realized regardless of the firm's states.

2. Incompleteness of Contracts

Next, we consider the contractual incompleteness case. To compare the union case with the non-union case, the three following results are shown.

Proposition 1

$w_U < w_F$

Proof

See Appendix.

Proposition 2

$\theta^* > \theta^{**}$

Proof

See Appendix.

Proposition 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.

Proposition 3 implies that $\forall\theta \in (0, \bar{\theta}]$ $\quad L_U(\theta) \geq L_F(\theta)$: full employment is more likely with a union than without a union. A union exercises its power for job security so that the firm with the union loses free controllability of determinant of employment level. Since the firm and workers take this into account on making contracts, a lower wage offer is implemented.

Furthermore, by (8) and (12), it holds

$\forall\theta \in (0, \bar{\theta}]$ $\quad L_F(\theta) \leq L_C(\theta)$. $\quad \ldots(15)$

Under contractual incompleteness, since the firm cannot promise high job security, high wage and its consequent low job security, encourages workers to make efforts at skill accumulation. However, under full commitment, low wage and high job security are promised, and hence the result (15) holds. Next, comparing the union case with the full commitment case, an ambiguous result in employment level is obtained because θ^{**} may or may not be more than θ_C. However, when the reservation utility $\overline{w}$ is sufficiently low, it holds that $L_U(\theta) \leq L_C(\theta)$ for almost any state. Indeed, if $\overline{w} = 0$, since $L_C(\theta) = 1$ for any θ,

$$\forall\theta \in (0, \theta^{**}) \quad L_U(\theta) < L_C(\theta) = 1$$

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

Proposition 2 and 3 are reasonable since the union exercises its 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.

You may think that the wage results determined in these equations are not applicable in a real world setting since the results indicate that the wage in the firm with a union is less than that in a union less firm. Intuitively, it seems that the union's bargaining power raises wage. However, opinions are divided on the unions' effect on increasing wage.[2] Freeman and Medoff (1984) find that union wage is higher by about 20% over non-union wage in the U.S. manufacturing industry. Although unions' wage effect is large in the U.S., in other developed countries, as Blanchflower and Freeman (1992) have shown, the effect is small. Other studies reject the union's effect of increasing wage. Valleta (1993), using a longitudinal approach, points out that municipal unions' effect is insignificant in the U.S. Tachibanaki and Noda (1993), Brunello (1992), Kishi (1995), and Tsuru and Rebitzer (1995) show that the wage effect is negative or insignificant in Japan. To the contrary, Rebick (1993) and Ishikawa and Dejima (1996) report on the positive wage effect of unions.

Next, compare the firm's profit without a union versus that with a union. From (6) and (11), it holds that

$$\exists\hat{\theta} \in (\theta^{**}, \theta^{*}) \quad \hat{\theta}f(L_F(\hat{\theta})) - w_F L_F(\hat{\theta}) = \hat{\theta}f(1) - w_U, \qquad \ldots(16)$$

where $L_F(\hat{\theta})$ is employment level satisfying $\hat{\theta}f'(L_F) - w_F = 0$ (see figure Ⅲ). Hence, profit of the firm without a union is higher than that with a union under $\theta \in (0, \hat{\theta}]$. On the other hand, under $\theta \in [\hat{\theta}, \overline{\theta}]$, existence of a union enlarges the firm's profit.

Proposition 4

$$\forall\theta \in (0, \hat{\theta}) \qquad \pi_F > \pi_U$$
$$\theta = \hat{\theta} \qquad \pi_F = \pi_U$$
$$\forall\theta \in (\hat{\theta}, \bar{\theta}] \qquad \pi_F < \pi_U \ ,$$

where $\hat{\theta}$ satisfies (16).

Proof

See Appendix.

Proposition 4 implies that profit of the firm with the union is more than that without the union in a boom, and vice versa in a recession. Thus, existence of a strong union might increase expected profit. For example, consider a case of high workers' cost for skill accumulation such that IC under the non-union case is not satisfied but IC under the union case is satisfied. Obviously as seen in figure Ⅱ, the cases might occur. In the non-union case, $\Pi_F = 0$ because contracts are not enforceable. On the other hand, in the union case, $\Pi_U > 0$. Under contractual incompleteness, contracts are not enforceable without unions because the firms optimize the employment level *ex post*. However, the existence of strong unions makes contracts enforceable. It is the strong unions that play a significant role in job security and increase the firms' profits. Even if IC under non-union is satisfied, if w_F is sufficiently high, it holds that $\Pi_U > \Pi_F$. Although we have intentionally considered a strong union, the union exercising great power on job security enhances the firm's profit.

Proposition 5

There are cases whereby expected profit of the firm with a union exceeds that of the firm without a union if workers' skill accumulation cost is sufficiently high: $\Pi_U > \Pi_F$.

If $\Pi_U > \Pi_F$, the firm has an incentive for encouraging workers to organize a union. After wage is determined, the union's resistance policy decreases the firm's profit *ex post*. Obviously, after observing the state, existence of the union decreases the firm's 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, the union plays a significant role in job security of employees. Since the union raises employment stability, the firm can lower wage *ex ante*. Thus, if unions exercise strong power insisting on job security, then strong unions would be welcomed by firms.

Ⅳ. Bonus Bargaining

Consider bargaining between a firm and a union over profits. If the union extracts most of the firm's profit as a bonus payment, workers receive not only their regular wage determined by the contract which the firm must pay since it is verifiable, but also a bonus payment. The firm with the union retains less profit than the firm without unions. The stronger the union's power, the less pie is retained by the firm. Hence, conflicts between unions and firms would be likely making it difficult to construct good industrial relations. Furthermore, firms would hinder unions and its members. Even if a firm's obstacle is illegal, it is difficult and costly to verify the illegality. As a result, workers might have no incentive for organizing, managing and participating in unions. Actually, although union members in the U.S. receive about 20% higher wage, union membership rate has been rapidly decreasing in the U.S. Freeman and Medoff (1984) and Blanchflower and Freeman (1992) indicate that firms' offense to unions, which is caused by unions' effect of increasing wage, discourages workers to participate and manage unions. Unfortunately, if unions pay too much attention to increasing bonus payments, the role of unions as commitment devices, which is considered in the previous chapter, might be nullified by the harmful actions of firms.

Consider the case wherein 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. Therefore, the same result as the above statement on bonus bargaining is introduced.

Ⅴ. Wage Adjustment as Renegotiation

In the first period, the firm and workers cannot make contracts contingent on the state. After deciding on wage and making efforts at skill accumulation, a state is realized. After the state is observed, renegotiation might improve welfare of the workers and the firm.

Note that renegotiation occurs only in the case where a union exists. If a union is not organized, workers cannot observe the state adequately due to the huge cost of collecting information. In this case, the firm always has an incentive for reporting the state to be severe and decreasing wage even if the state is in actuality a boom. Hence,

workers would tend to not accept the renegotiation offer of the firm.

To focus on renegotiation as wage adjustment, we consider a simple production function:

$$f(L) = L^a \quad (0 < a < 1). \qquad \text{...(17)}$$

Clearly, this satisfies the assumption on the production function (1). The other cases are considered later.

Lemma 1

$L_U^{**}(\theta)$ is a strictly convex function with respect to θ for any state $\theta \in (0, \theta^{**}]$ under (17) (see figure Ⅳ).

Proof

See Appendix.

1. Existence of Renegotiation Cost

After observing the state, timing of renegotiation is as follows (see figure Ⅴ):

① The firm and the union observe the realized state.

② If renegotiation does not occur, the original contract is executed. However, if the firm offers renegotiation, its costs must be sufficiently low and non-pecuniary $\varepsilon(>0)$ for the firm to offer a new wage in renegotiation.

③ If the union accepts the new verifiable wage, it then determines a new resistance policy given the new wage. On the other hand, if the union rejects the renegotiation offer, the original contract is maintained and the old resistance policy is instituted.

As we have shown, when a state θ is realized and renegotiation is not accepted, wage determined by the original contract is paid and $L_U(\theta)$ is employed as a result of the union's proper resistance policy. In this case, a worker's expected utility is $w_U L_U(\theta) + (1 - L_U(\theta))\overline{w}$. If wage is decreased and employment is increased while workers' expected utility is kept the same, the firm can increase its profit.

The new wage determined by renegotiation is denoted as $\tilde{w}_U$. We consider the following incentive compatibility for acceptance of renegotiation:

$$w_U L_U(\theta) + (1 - L_U(\theta))\overline{w} \le \tilde{w}_U(\theta)\tilde{L}(\theta) + (1 - \tilde{L}(\theta))\overline{w}, \qquad \text{...(18)}$$

where the new employment level $\tilde{L}$ is determined by the appropriate resistance policy of the union under the new wage $\tilde{w}_U$. It is clear that the new employment level and wage are functions of the state. Inequality (18) indicates that the newly offered expected wage is more than the original expected wage. Inequality (18) is rewritten by

$$(w_U - \overline{w})L_U(\theta) \leq (\tilde{w}_U(\theta) - \overline{w})\tilde{L}(\theta). \quad \text{...(18)'}$$

The left hand of (18)' is positive by $w_U > \overline{w}$, and hence it holds $\tilde{w}_U(\theta) > \overline{w}$ if a renegotiation offer is accepted. Notice that $\tilde{w}_U(\theta) = \overline{w}$ never occurs because the firm must compensate workers' rent in the original contract at the renegotiation stage, which comes from the training cost.

Under $\theta \geq \theta^{**}$, renegotiation does not occur. Because the firm cannot increase employment by decreasing wage, the firm has no incentive for renegotiation. However, if the state is slightly severe, renegotiation might increase the firm's profit.

Consider an another case. Because non-pecuniary renegotiation cost ε exists, the firm is not willing to offer renegotiation if the firm never gets a positive profit after the renegotiation cost has been sunk. First, we show that the firm cannot get a positive profit if $\tilde{L} < 1$. If the firm offers a new wage in renegotiation, the union determines whether to accept or not. The union will accept and determine a new resistance policy if inequality (18)' is satisfied. The new resistance policy of the union leads to a new employment level $\tilde{L}$ given the new wage $\tilde{w}_U$.

From a view of backward induction consideration, we consider this example $\theta f(1) - \tilde{w}_U < 0$ given θ *and* $\tilde{w}_U$. Since the union cannot realize full employment under a renegotiation offer $\tilde{w}_U$, the union will choose a new resistance policy as follows:

$$\tilde{R}(\theta, \tilde{L}) = \begin{cases} 0 & \text{if} \quad \tilde{L} \geq \tilde{L}^{**}(\theta) \\ \dfrac{\theta f(\tilde{L}) - \tilde{w}_U \tilde{L}}{1 - \tilde{L}} & \text{if} \quad \tilde{L} < \tilde{L}^{**}(\theta) \end{cases}, \quad \text{...(19)}$$

where $\tilde{L}^{**}(\theta)$ is the employment level under the state θ satisfying $\theta f(\tilde{L}) - \tilde{w}_U \tilde{L} = 0$ *and* $\tilde{L} < 1$. ...(20)

After the firm's renegotiation cost ε has been sunk, the union will get the entire pie produced, and hence (19) and (20) hold. After all, the firm sees a loss, which is equivalent to the non-pecuniary renegotiation cost ε, by offering renegotiation to the union. Thus, since the firm takes this into consideration, the firm never offers renegotiation under this scenario.

In the second case, full employment is realized by renegotiation. To enforce renegotiation, it is necessary that (18) and the following condition (positive profit condition) are satisfied,

$$\theta f(1) - \tilde{w}_U \geq \varepsilon. \quad \text{...(21)}$$

Since the firm's renegotiation cost ε is sufficiently low, (21) is replaced as follows:

$$\theta f(1) - \tilde{w}_U > 0. \qquad \text{...(21)'}$$

No problem occurs by considering (21)' instead of (21). Suppose that there are non-empty sets $(\theta, w_U, L_U, \tilde{w}_U)$ satisfying (18) and (21)'. Indeed, if $\overline{w}$ is sufficiently low, the sets exist (proposition 8). The following result is obtained.

Proposition 6

When (17) holds and non-pecuniary renegotiation cost is sufficiently low but positive, renegotiation occurs under the following state and leads to full employment by wage adjustment:

$$\forall\theta \in (\tilde{\theta}, \theta^{**}) \quad \tilde{w}_U(\theta) = (w_U - \overline{w})L_U(\theta) + \overline{w} < w_U \quad \textit{and} \quad \tilde{L}(\theta) = 1,$$

where $L_U(\theta)$ and w_U are determined by (3), (4) and (5), and $\tilde{\theta}$ satisfies $\tilde{\theta} f(1) = (w_U - \overline{w})L_U(\tilde{\theta}) + \overline{w}$.

Further, the original contract is identical regardless of renegotiation, i.e., existence of renegotiation never influences the original contract.

Proof

Consider the following equation

$$\tilde{w}_U = \theta f(1) \quad \theta \in [0, \theta^{**}]. \qquad \text{...(22)}$$

The right hand of (22) is linear with respect to θ and (22) satisfies these cases: $(\tilde{w}_U, \theta) = (w_U, \theta^{**}), (0, 0)$. (See figure Ⅵ). On the other hand, using (18) and $\tilde{L}(\theta) = 1$, consider this equation:

$$\tilde{w}_U = (w_U - \overline{w})L_U(\theta) + \overline{w} \qquad \theta \in [0, \theta^{**}]. \qquad \text{...(23)}$$

The right hand of (23) is a strictly convex function of θ since L_U is a strictly convex with respect to θ under (17). Note that w_U is given under the renegotiation stage. Moreover, (23) satisfies these cases: $(\tilde{w}_U, \theta) = (w_U, \theta^{**}), (\overline{w}, 0)$. If (22) and (23) have solutions besides $(\tilde{w}_U, \theta) = (w_U, \theta^{**})$, the other solution $(\tilde{w}_U, \tilde{\theta})$ exists uniquely, and satisfies the following equation (figure Ⅵ):

$$\tilde{\theta} f(1) = (w_U - \overline{w})L_U(\tilde{\theta}) + \overline{w},$$

where $L_U(\tilde{\theta})$ is the employment level under the state $\tilde{\theta}$ satisfying $\tilde{\theta} f(L_U) - w_U L_U = 0$. Inequalities (18) and (21)' hold in the shaded area in figure Ⅵ. Therefore, renegotiation occurs under the state $\theta \in (\tilde{\theta}, \theta^{**})$ since the firm makes a positive profit by renegotiation. Note that under $\theta = \tilde{\theta}$, (21)' is not satisfied, i.e., the firm can not recover the non-pecuniary renegotiation cost. Since the firm offers the minimum wage in renegotiation satisfying (18)' and $\tilde{L}(\theta) = 1$, it holds that

$$\forall\theta \in (\tilde{\theta}, \theta^{**}) \quad \tilde{w}_U(\theta) = (w_U - \overline{w})L_U(\theta) + \overline{w}.$$

Using $L_U(\theta) < 1$ under $\theta < \theta^{**}$, $\tilde{w}_U(\theta) < w_U$ holds.

Renegotiation yields the expected utility equivalent to the original contract for

workers since the union's incentive compatibility for renegotiation (18) is always binding in this case. Hence, the existence of renegotiation never influences the firm or the workers when they make the original contract. The original contract is identical with or without the existence of renegotiation.■

This implies that wage adjustment occurs as a result of renegotiation. The firm's profit increases by renegotiation while workers' utility is identical. Using $\tilde{w}_U(\theta) < w_U$, the firm's profit is positive with renegotiation,

$$\forall\theta \in (\tilde{\theta}, \theta^{**}) \quad \theta f(1) - \tilde{w}_U(\theta) > \theta f(L_U) - w_U L_U = 0.$$

Under $\theta \in (\tilde{\theta}, \theta^{**})$, renegotiation occurs under $\varepsilon > 0$. However, under $\theta \in (0, \tilde{\theta}]$, both (18) and (21)' are not satisfied, and thereby renegotiation never occurs so that the original contract is executed. When the firm and the union face a mildly severe state, wage decreases instead of the employment level increasing. Wage adjustment prevents the firm from dismissing some workers as a result of the renegotiation. Unfortunately, under a more severe state, the firm cannot avoid employment adjustment.

Proposition 7

It is obtained under (17) that some workers are dismissed under severe states $\theta \in (0, \tilde{\theta}]$; renegotiation brings wage adjustment and full employment under slightly severe states $\theta \in (\tilde{\theta}, \theta^{**})$; and under $\theta \in [\theta^{**}, \bar{\theta}]$, renegotiation does not occur and full employment is realized.

Consider the case such that (17) does not hold. In this case, similarly, the firm will not offer renegotiation wage under $\theta \geq \theta^{**}$ since the firm cannot increase employment level. To the contrary, ranges of states renegotiation occurs may be discrete. For example, we consider three states: $\theta_1 < \theta_2 < \theta_3 < \theta^{**}$. It does not necessarily hold that $L_U^{**}(\theta)$ is a strictly convex function. Hence, we cannot exclude the case wherein renegotiation occurs at the states θ_1 *and* θ_3, however, does not at θ_2 (see figure Ⅶ).

However, if $\bar{w} = 0$, renegotiation occurs and realizes full employment level under $\theta \in (0, \theta^{**}]$. Note that proposition 8 holds whether condition (17) is satisfied or not.

Proposition 8

If $\bar{w} = 0$, renegotiation avoids the dismissal of any worker, and wage adjustment is realized: $\tilde{L}(\theta) = 1$ under $\theta \in (0, \theta^{**})$.

Proof

If $\overline{w} = 0$, (23) is expressed by

$$\tilde{w}_U = w_U L_U(\theta) \qquad \theta \in [0, \theta^{**}]. \qquad \text{...(23)'}$$

Obviously,

$$0 = \theta f(L_U) - w_U L_U < \theta f(1) - w_U L_U$$
$$= \theta f(1) - \tilde{w}_U .$$

Hence, $\theta f(1) - \tilde{w}_U > 0$, then (21)' always holds. Therefore, the firm offers a new wage $\tilde{w}_U = w_U L_U(\theta)$ and full employment is realized under $\theta \in (0, \theta^{**})$.■

Clearly, proposition 8 holds under no renegotiation cost case considered in the next section.

2. No renegotiation Cost

Next consider the case of $\varepsilon = 0$. The firm may offer a new wage while the firm realizes zero profit and $\tilde{L} < 1$ by renegotiation. This is different from the case wherein a renegotiation cost exists. The reason is that renegotiation can increase workers' *ex post* expected utility even if the firm's profit is zero. Since renegotiation is not costly for the firm, that is, it is indifferent for the firm to renegotiate or not, the firm offers a new wage which leads to workers' high expected utility. The firm and workers take this into consideration when making the *ex ante* original contract. Hence, the firm can offer a lower wage in the original contract than in the case without renegotiation, and workers accept it. A lower wage offer increases the firm's expected profit. Thus, even if full employment is not enforceable by renegotiation under some states, the firm intends to offer a new wage to maximize workers' *ex post* utility: $\tilde{w}_U^0(\theta)\tilde{L}^0(\theta) + (1 - \tilde{L}^0(\theta))\overline{w}$, where $\tilde{w}_U^0(\theta)$ *or* $\tilde{L}^0(\theta)$ is wage or employment level in renegotiation under $\varepsilon = 0$ when a state θ is realized. Note that, if full employment is not realized, zero profit is realized by the union's proper resistance policy. Under no renegotiation cost, whatever a renegotiation wage level is offered by the firm never changes the *ex post* firm's profit: zero profit is realized regardless of new wage offers. Then, any wage offer will implement an equilibrium. We will focus on the case wherein the firm offers the wage level maximizing the expected utility of workers because the case is the most contrary to the no renegotiation cost case.

When renegotiation brings zero profit, the firm maximizes workers' *ex post* rents: $(\tilde{w}_U^0(\theta) - \overline{w})\tilde{L}^0(\theta)$. ...(24)

First, we consider the renegotiation stage for backward induction consideration. At this stage, a wage in the original contract w_U^0 is given. As we have shown under

$\varepsilon > 0$, the same results are introduced under (17) in the same manner, i.e., renegotiation never occurs under $\theta \in [\theta_0^{**}, \bar{\theta}]$, where $\theta_0^{**} \equiv \frac{w_U^0}{f(1)}$. Full employment and wage adjustment are realized as a result of renegotiation under $\theta \in [\tilde{\theta}_0, \theta_0^{**})$, where $\tilde{\theta}_0$ satisfies

$$\tilde{\theta}_0 f(1) = (w_U^0 - \bar{w}) L_U^0(\tilde{\theta}_0) + \bar{w}. \quad \text{...(25)}$$

Renegotiation under $\theta \in (\tilde{\theta}_0, \theta_0^{**})$ yields positive profit to the firm.

Furthermore, under $\theta \in (0, \tilde{\theta}_0]$, renegotiation may be offered even if renegotiation gives no *ex post* profit to the firm. In this case, renegotiation yields the *ex post* maximum rents to workers. It holds that $\tilde{L}^0 < 1$, and thereby, in the same manner of the existence of renegotiation cost, the union's appropriate resistance policy under the renegotiation stage leads to zero profit:

$$\theta f(\tilde{L}^0) - \tilde{w}_U^0 \tilde{L}^0 = 0. \quad \text{...(26)}$$

Hence, under $\theta \in (0, \tilde{\theta}_0)$, the firm offers a new wage to maximize workers' rents (24) subject to the equation (26). By solving this problem, $\tilde{L}^0$ is determined to satisfy

$$\theta f'(\tilde{L}^0) - \bar{w} = 0. \quad \text{...(27)}$$

A new wage offer is determined by (26) and (27).

Note that renegotiation occurs under $\theta \in (0, \tilde{\theta}_0)$ only when the incentive compatibility for the union's acceptance of renegotiation is not binding. If it is binding, strict concavity of the production function and (27) lead to $\tilde{L}^0(\theta) = L_U^0(\theta)$, $\tilde{w}_U^0(\theta) = w_U^0(\theta)$, i.e., renegotiation is insignificant.

Lemma 2

If the incentive compatibility for renegotiation is binding under $\theta \in (0, \tilde{\theta}_0)$, then the renegotiation offer is insignificant: $\tilde{L}^0(\theta) = L_U^0(\theta) < 1$, $\tilde{w}_U^0(\theta) = w_U^0(\theta)$.

Proof

See Appendix.

Taking into consideration that renegotiation maximizes workers' ex post rent and can yield more rent than in the original contract under $\theta \in (0, \tilde{\theta}_0)$, the incentive compatibility for skill accumulation is considered. Workers' expected utility is

$$U_U^0 \equiv \int_0^{\tilde{\theta}_0} \left[\tilde{L}^0(\theta)\tilde{w}_U^0(\theta) + (1 - \tilde{L}^0(\theta))\bar{w}\right]\phi(\theta)d\theta + \int_{\tilde{\theta}_0}^{\theta_0^{**}} \tilde{w}_U^0(\theta)\phi(\theta)d\theta + (1 - F(\theta_0^{**}))w_U^0 - c,$$

where it holds that $\tilde{L}^0(\theta) = 1$ under $\theta \in (\tilde{\theta}_0, \theta_0^{**})$ from proposition 6. Incentive compatibility with consideration for renegotiation is $U_U^0 \geq \bar{w}$. This IC is binding by maximization of profit, and the wage w_U^0 in the original contract is determined. The

firm's expected profit is

$$\Pi_U^0 = \int_{\tilde{\theta}_0}^{\theta_0^{**}} \{\theta f(1) - \tilde{w}_U^0(\theta)\}\phi(\theta)d\theta + \int_{\theta_0^{**}}^{\bar{\theta}} \{\theta f(1) - w_U^0\}\phi(\theta)d\theta .$$

The existence of renegotiation improves the firm's profit by decreasing wage in the original contract.

Proposition 9

When the renegotiation offer cost does not exist under (17), renegotiation occurs under $\theta \in (0, \theta_0^{**})$:

$$\forall\theta \in [\tilde{\theta}_0, \theta_0^{**}) \quad \tilde{w}_U^0(\theta) = (w_U^0 - \overline{w})L_U^0(\theta) + \overline{w} < w_U^0 \quad and \quad \tilde{L}^0(\theta) = 1$$

where $\tilde{\theta}_0$ satisfies $\tilde{\theta}_0 f(1) = (w_U^0 - \overline{w})L_U^0(\tilde{\theta}_0) + \overline{w}$;

$\forall\theta \in (0, \tilde{\theta}_0)$ $\tilde{w}_U^0(\theta) = \dfrac{\theta f(\tilde{L}^0(\theta))}{\tilde{L}^0(\theta)}$, *where* $\tilde{L}^0(\theta)\ (<1)$ is the employment level under the state θ satisfying $\theta f'(\tilde{L}^0) - \overline{w} = 0$ and states renegotiation is insignificant can exist.

Proof

See above.

In the case of $\varepsilon = 0$, renegotiation does not always decrease wage and increase employment level under $\theta \in (0, \tilde{\theta}_0)$. A higher wage and a lower employment level might be realized in renegotiation (See figure Ⅷ). Suppose that (w_U^0, L_U^0) expressed by A is realized under the original contract. On the other hand, renegotiation leads to B. This result is brought about by maximizing workers' *ex post* rents.

Ⅵ. Conclusion

In this paper, we have provided a new role of unions as commitment devices. In the real world, complete contracts are rarely made due to bounded rationality or huge cost, and hence contracts are apt to be incomplete. We considered a union's role when applying incomplete contract theory. Under incompleteness of contracts, when wage and dismissal contingent on the states are not described in labor contracts although the wage offer is verifiable, the firm cannot promise to maintain employment *ex ante* and cannot make employees believe the promise of job security. Thus, the firm must offer a high wage to induce its workers to make efforts. However, if a strong union exists and resists the firm's dismissal policy, the union plays a significant role as a commitment device for

job security. Hence, the firm can decrease wage *ex ante*, and we have a case whereby the expected profit of the firm with the strong union is more than that without a union. Strong unions might be welcomed by firms because unions play the role of commitment devices for job security.

Under contractual incompleteness, renegotiation may improve the welfare of the firm and the union after the state is realized. We considered wage adjustment as renegotiation. If renegotiation does not occur, rent of employees depends on the wage determined by the original contract and the union's resistance policy. The firm might be able to compensate the rent by offering a new wage. Although the new wage is less than the original wage, the lower wage implements an increase of the employment level. Hence, workers keep the same level of the rent, and the firm increases its profit. Further, we have shown that wage adjustment as renegotiation occurs in a slightly severe recession, but that in a severe recession employment adjustment cannot be avoided. This result is consistent with observed facts except when considering the blue collar workers in the U.S.

In this paper, we focus on unions' effect on job security, and we did not consider wage negotiation between unions and firms. If unions exercise great power on bonus bargaining, the results might be influenced. Consider the case whereby unions obtain most of the profit through tough bargaining power in a boom. It is obvious that unions' bargaining power decreases firms' profits. 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, if unions extract profits, conflicts between unions and firms are likely, and it is difficult to establish good industrial relations. Freeman and Medoff (1984) indicate that various attacks on unions exist reducing union membership rates and power in the U.S. In Japan, as Okochi and Matsuo (1969) and Hyodo (1997) mention, there are disturbances to union activities by firm managers. Therefore, the purpose of unions should be based on job security rather than on increasing wage. Although the manner of employment adjustment is different in every country, various laws and institutions address job security. Unions are a complement to those laws. As Abraham and Houseman (1993) and Koike (1991) mention, high job security matters, and hence a role of unions is to establish job security under incompleteness of contracts.

Appendix

Proof of proposition 1

Suppose that $w_U = w_F = w$. In this case, it holds that $\theta^{**} \equiv \frac{w}{f(1)} < \theta^{*} \equiv \frac{w}{f'(1)}$ by strict concavity of product function. Hence, under $\theta \in [\theta^{**}, \bar{\theta}]$, $L_U(\theta) = 1 \geq L_F(\theta)$. On the other hand, under $\theta \in (0, \theta^{**})$, equation (3) and (7) indicate that employment level for any state with the union is higher than that state without the union. Thereby it holds that $U_U(w) > U_F(w)$: workers' expected utility in the firm with the union is larger than that without the union if an identical wage is offered. Note that U_U and U_F are functions of wage. If $w \leq \bar{w}$, it is clear that $\bar{w} > U_U(w) > U_F(w)$. Hence, if it is assumed that $U(w)$ is continuous, and contracts with the firm are enforceable, there is the minimum solution w of $U_U(w) = \bar{w}$, and when $U_F(w) < \bar{w}$ (See figure Ⅱ). Since the firm maximizes its profit, it chooses the minimum wage satisfying the incentive compatibility. Thus, it is determined that $w_U < w_F$.■

Proof of proposition 2

Using proposition 1, strict concavity of the production function and $f(0) = 0$,

$$\theta^{*} - \theta^{**} = \frac{w_F}{f'(1)} - \frac{w_U}{f(1)} > w_F\left(\frac{1}{f'(1)} - \frac{1}{f(1)}\right) > 0.$$■

Proof of proposition 3

Under $0 < \theta < \theta^{**}$, consider an employment level $\hat{L}$ which satisfies $\theta f'(L_F) - w_F = \theta f'(\hat{L}) - w_U = 0$. It is clear that $L_F < \hat{L}$ from proposition 1. Since $\hat{L} < L_U$, it holds $L_U > L_F$. Next consider $\theta^{**} \leq \theta < \theta^{*}$. In this case, it is clear that $L_U = 1 > L_F$. Finally, in the case of $\theta^{*} \leq \theta \leq \bar{\theta}$, $L_U = L_F = 1$.■

Proof of proposition 4

Obviously, it holds that $\pi_F(\theta) > \pi_U(\theta) = 0$ under $0 < \theta \leq \theta^{**}$ and $\pi_F(\theta) < \pi_U(\theta)$ under $\theta^{*} \leq \theta \leq \bar{\theta}$. Since $\pi_U(\theta) = 0$ under $0 < \theta \leq \theta^{**}$ and $\pi_U(\theta) = \theta f(1) - w_U > 0$ under $\theta^{**} < \theta \leq \bar{\theta}$, $\pi_U(\theta)$ is a linear function with the state θ under $\theta^{**} < \theta \leq \bar{\theta}$. On the other hand, $\frac{d\pi_F(\theta)}{d\theta} = f(L_F(\theta)) > 0$ from envelope theorem and $\frac{dL_F(\theta)}{d\theta} > 0$ under $0 < \theta \leq \theta*$. $\pi_F(\theta)$ is a strict convex increasing function with θ under $0 < \theta \leq \theta^{*}$. Hence, the maximum of $\pi_F'(\theta)$ is $f(1)$ under $\theta \in (0, \theta^{*}]$. Under $\theta^{*} \leq \theta \leq \bar{\theta}$, $\pi_F(\theta)$ is a linear

function with the state θ, where $\pi_F'(\theta) = f(1)$. Therefore, $\pi_F(\theta)$ is drawn like figure Ⅲ. By $\pi_F(0) = 0$, $\hat{\theta}$ satisfying (16) exists. Accordingly, this proposition is proved.■

Proof of lemma 1

Differentiating $\pi(\theta, L) = 0$, it holds that $\frac{dL}{d\theta} = -\frac{\pi_\theta}{\pi_L}$ ...(A1)

where π_i $(i = \theta, L)$ stands for $\frac{\partial \pi}{\partial i}$. Further, $\frac{d^2L}{d\theta^2} = -\frac{d(\pi_\theta/\pi_L)}{d\theta} = \frac{1}{\pi_L^3}\begin{vmatrix} \pi_{\theta\theta} & \pi_{\theta L} & \pi_\theta \\ \pi_{\theta L} & \pi_{LL} & \pi_L \\ \pi_\theta & \pi_L & 0 \end{vmatrix}$.

Under $f(L) = L^a$ $(0 < a < 1)$, it holds that $\pi_{\theta\theta} = 0$, $\pi_\theta = f(L)$, $\pi_{\theta L} = f'(L)$, *and* $\pi_{LL} = \theta f''(L)$. Then,

$$\begin{vmatrix} \pi_{\theta\theta} & \pi_{\theta L} & \pi_\theta \\ \pi_{\theta L} & \pi_{LL} & \pi_L \\ \pi_\theta & \pi_L & 0 \end{vmatrix} = 2f(\theta f' - w)f' - f^2\theta f'' \ . \qquad \text{...(A2)}$$

Substituting $w = \frac{\theta f}{L}$ to (A2), it is obtained that

$$\begin{aligned} 2f(\theta f' - w)f' - f^2\theta f'' &= -\frac{\theta f}{L}\left(2f'(f - f'L) + ff''L\right) \\ &= -wa(1-a)L^{2a-1} < 0 \end{aligned}$$

Note $\pi_L = \theta f'(L) - w < 0$ by $\pi(\theta, L) = 0$. Hence, it holds that $\left.\frac{d^2L}{d\theta^2}\right|_{\pi(\theta, L)=0} > 0$ under $f(L) = L^a$ $(0 < a < 1)$.■

Proof of lemma 2

The IC is binding: $(\tilde{w}_U^0 - \overline{w})\tilde{L}_U^0 = (w_U^0 - \overline{w})L_U^0$. ...(A3)

Using (26), (27) and $\theta f(L_U^0) - w_U^0 L_U^0 = 0$, (A3) is replaced by

$$f(L_U^0) - f(\tilde{L}_U^0) = f'(\tilde{L}_U^0)(L_U^0 - \tilde{L}_U^0). \qquad \text{...(A4)}$$

Under $\theta \in (0, \tilde{\theta}_0)$, strict concavity of the production function and (A4) lead to $\tilde{L}^0(\theta) = L_U^0(\theta) < 1$. Hence, $\tilde{w}_U^0(\theta) = w_U^0(\theta)$.■

References

Abraham, Katharine G. and Susan N. Houseman, "Job Security in America: Lessons from Germany", (Washington, D.C.: *The Brookings Institution,* 1993).

Addison, John T. and Barry T. Hirsch, "Union Effects on Productivity, Profits, and Growth: Has the Long Run Arrived?", *Journal of Labor Economics,* 7 (1989), 72-105.

Agihon, Philippe and Patrick Bolton, "An Incomplete Contracts Approach to Financial Contracting", *Review of Economic Studies,* 59 (1992), 473-494.

---------- **and Jean Tirole,** "Formal and Real Authority in Organizations" *Journal of Political Economy,* 105 (1997), 1-29.

Aoki, Masahiko, "Information, Incentives, and Bargaining in the Japanese Economy", (Cambridge, Cambridge: *Cambridge University Press,* 1988).

Becker, Brian E. and Craig A. Olson, "Unions and Firm Profits", *Industrial Relations,* 31 (1992), 395-415.

Brunello, Giorgio, "The Effect of Unions on Firm Performance in Japanese Manufacturing", *Industrial and labor Relations Review,* 45 (1992), 471-487.

Blanchflower, David G. and Richard B. Freeman, "Unionism in the United States and Other Advanced OECD Countries", *Industrial Relations,* 31 (1992), 56-79.

Cremer, Jacques, "Arm's Length Relationships" *Quarterly Journal of Economics,* 110 (1995), 275-295.

Dewatripont, Mathias and Eric Maskin, "Credit and Efficiency in Centralized and Decentralized Economies" *Review of Economic Studies,* 62 (1995), 541-555.

Dewatripont, Mathias and Jean Tirole, "A Theory of Debt and Equity: Diversity of Securities and Manager-Shareholder Congruence" *Quarterly Journal of Economics,* 109 (1994), 1027-1054.

Freeman, Richard B., "American Exceptionalism in the Labor Market: Union-Nonunion Differentials in the United States and Other Countries", in Kerr, Clark and Paul D. Staudohar, eds., "Labor Economics and Industrial Relations: Markets and Institutions" (Cambridge, Massachusetts: *Harvard University Press,* 1994).

---------- **and James L. Medoff,** "What Do Unions Do?",

(New York: *Basic Books*, 1984).

Grossman, Sanford J. and Oliver D. Hart, "The Costs and Benefits of Ownership: A theory of Vertical and Lateral Integration" *Journal of Political Economy*, 94 (1986), 691-719.

Gu, Wulong and Peter Kuhn, "A Theory of Holdouts in Wage Bargaining" *American Economic Review*, 88 (1998), 428-449.

Hart, Oliver D., "Bargaining and Strikes", *Quarterly Journal of Economics*, 104 (1989), 25-43.

---------- **and John Moore,** "Incomplete Contracts and Renegotiation" *Econometrica,* 56 (1988), 755-786.

---------- **and ----------,** "Property Rights and the Nature of the Firm" *Journal of Political Economy*, 98 (1990), 1119-1158.

Hayse, Beth, "Unions and Strikes with Asymmetric Information", *Journal of Labor Economics*, 2 (1984), 57-83.

Hirschman, Albert O., "Exit, Voice, and Loyalty", (Cambridge, Massachusetts: *Harvard University Press*, 1970).

Hyodo, Tsutomu, "A History of Industrial Relations in Japan,1945-1989, vol.1&2" ("Rodo no Sengoshi" in Japanese), (Tokyo: *University of Tokyo Press*, 1997).

Ishiguro, Shingo and Yoshimasa Shirai, "Entry Deterrence in a Unionized Oligopoly" *Japanese Economic Review*, 49 (1998), 210-221.

Ishikawa, Tsuneo and Takahisa Dejima, "Unions effects on Increasing wage in Japan", ("Nippon no Rodo-Kumiai no Chingin Koka" in Japanese), *mimeo.* 1995.

Itoh, Hideshi and Osamu Hayashida, "Hiving Off and the Delegation of Authority: An Incomplete Contract Approach" ("Bunsya-ka to Kengen Ijyo: Fu-kanbi Keiyaku Approach" in Japanese), *Nippon Keizai Kenkyu*, 34 (1997), 89-117.

Kennan, John, "The Economics of Strikes", in Ashenfelter, Orley and Richard Layard, eds., "Handbook of Labor Economics" (Amsterdam: *North-Holland*, 1986).

Kishi, Tomoko, "Reduced Hours of Work and Workers' Utility", *mimeo*, 1995.

Koike, Kazuo, "Participation of Unions in workshops: Comparative Analysis on industrial Relations in Japan and U.S." ("Syokuba no Rodo-Kumiai to Sanka: Roshi-Kankei no Nichibei hikaku" in Japanese), (Tokyo: *Toyo-Keizai shinpo*, 1977).

----------, "Economics of Job" ("Shigoto no Keizaigaku" in Japanese),

(Tokyo: *Toyo-Keizai Shinpo*, 1991).

Lewis, Gregg H., "Union Relative Wage Effects", in Ashenfelter, Orley and Richard Layard, eds., "Handbook of Labor Economics" (Amsterdam: *North-Holland*, 1986).

McDonald, Ian M. and Robert Solow, "Wage Bargaining and Employment" *American Economic Review*, 71 (1981), 896-908.

Muramatsu, Kuramitsu, "An Analysis of Japanese Labor Market" ("Nippon no Rodo Shijyo Bunseki" in Japanse), (Tokyo: *Hakuto-Shobo*, 1983).

----------, "The Effects of the Trade Unions on Productivity in Japanese Manufacturing Industries", in Aoki, Masahiko, eds., "The Economic Analysis of the Japanese Firm" (Amsterdam: *North-Holland*, 1984).

Okochi, Kazuo and Hiroshi Matsuo, "A Story of the Japanese Unions: Post War" ("Nippon Rodo Kumiai Monogatari: Sengo-hen" in Japanese), (Tokyo: *Chikuma-Syobo,* 1969).

Qian, Yingyi and Chenggang Xu, "Innovation and Bureaucracy under Soft and Hard Budget Constraints" *Review of Economic Studies*, 65 (1998), 151-164.

Rebick, Marcus E., "The Persistence of Firm-Size Earnings Differentials and Labor Market Segmentation in Japan", *Journal of the Japanese and International Economies*, 7 (1993), 132-156.

Schmidt, Klaus M., "The Costs and Benefits of privatization" *Journal of Law, Economics, and Organization,* 12 (1996), 1-24.

Tachibanaki, Toshiaki and Tomohiko Noda, "Wage, Environment of Workshop, and Unions" ("Chingin, Rodo Jyoken to Rodo Kumiai" in Japanese), in Tachibanaki, Toshiaki, eds., "Economics of Unions" ("Rodo Kumiai no Keizaigaku" in Japanese) (Tokyo: *Toyo-Keizai Shinpo*, 1993).

Tomita,Yasunobu, "Quit Rate and Effects of Unions' Voices" ("Risyoku-ritsu to Rodo Kumiai no Hatsugen Koka" in Japanese), in Tachibanaki, Toshiaki, eds., "Economics of Unions" ("Rodo Kumiai no Keizaigaku" in Japanese) (Tokyo: *Toyo-Keizai Shinpo*, 1993).

Tracy, Joseph S., "An Empilical Test of an Asymmetric Information Model of Strikes", *Journal of Labor Economics*, 5 (1987), 149-173.

Tsuru, Tsuyoshi and Rebitzer James B., "The Limits of Enterprise Unionism: Prospects for Continuing Union Decline in Japan", *British Journal of Industrial Relations*, 33 (1995), 459-492.

Valetta, Robert G., "Union Effects on Municipal Employment and Wages: A Longitudinal Approach", *Journal of Labor Economics,* 11 (1993), 545-574.

Notes

1. No cost assumption is frequently used for simplification. For example, Cremer (1995) assumes no cost to monitor agents.

2. See Freeman (1994), Addison and Hirsch (1989), or Lewis (1986) for empirical studies on unions' effects on wage, employment, job tenure, fringe benefits and profit, etc. in developed countries.

Figure I

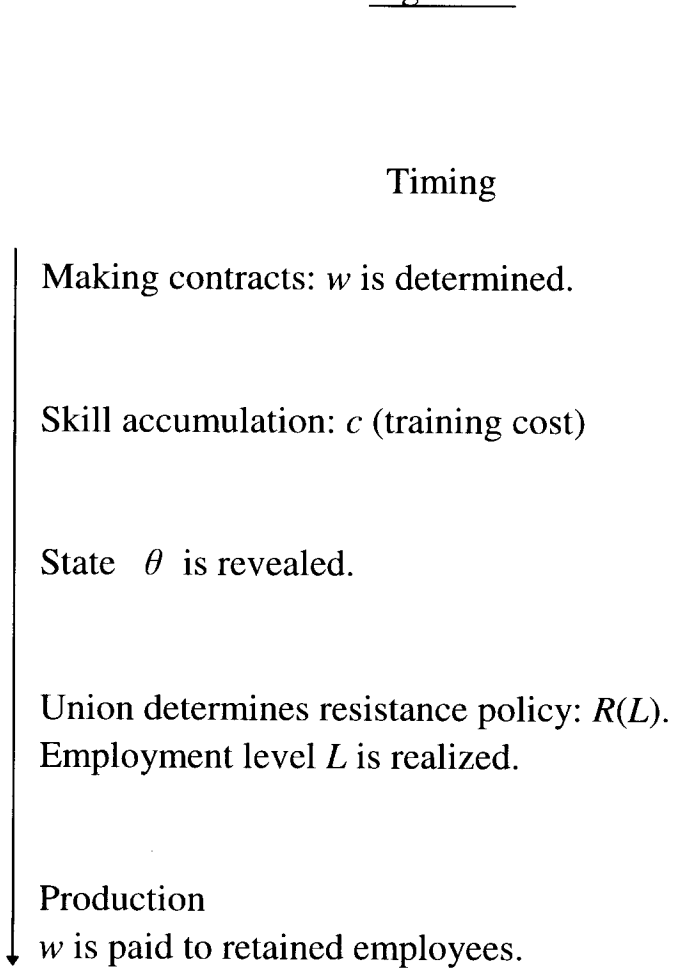
Timing
Making contracts: w is determined.
Skill accumulation: c (training cost)
State θ is revealed.
Union determines resistance policy: $R(L)$.
Employment level L is realized.
Production
w is paid to retained employees.

Figure Ⅱ

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.

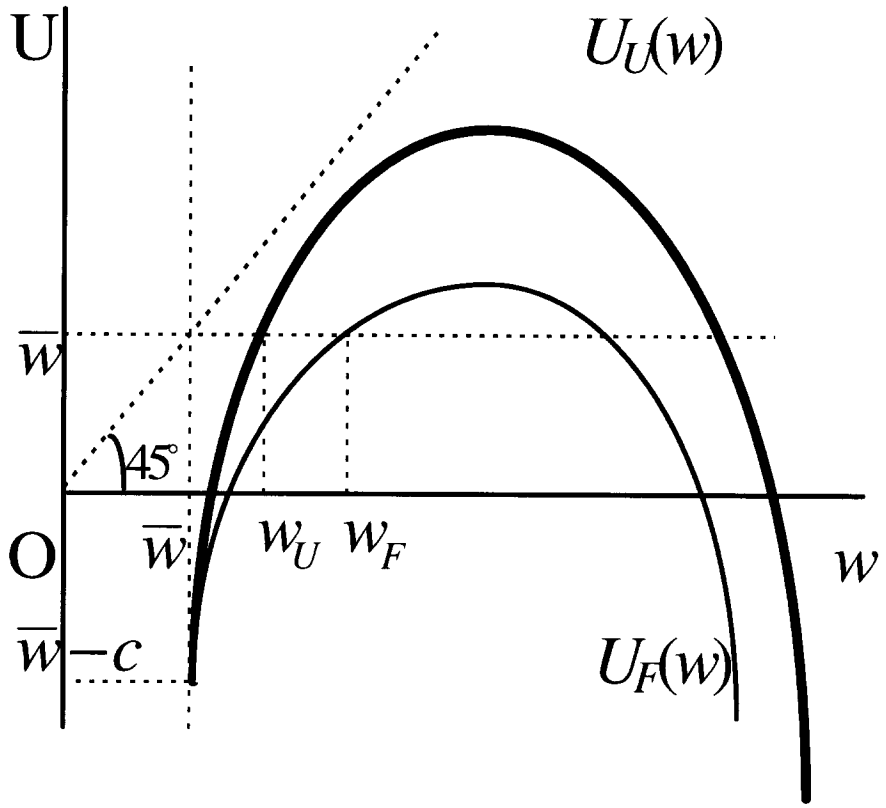

Figure Ⅲ

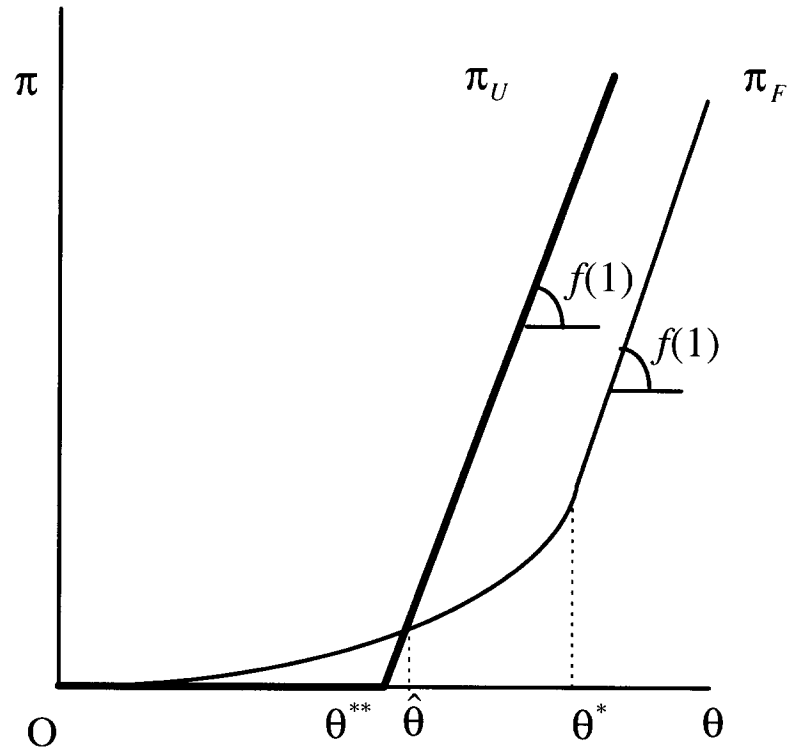

Figure Ⅳ

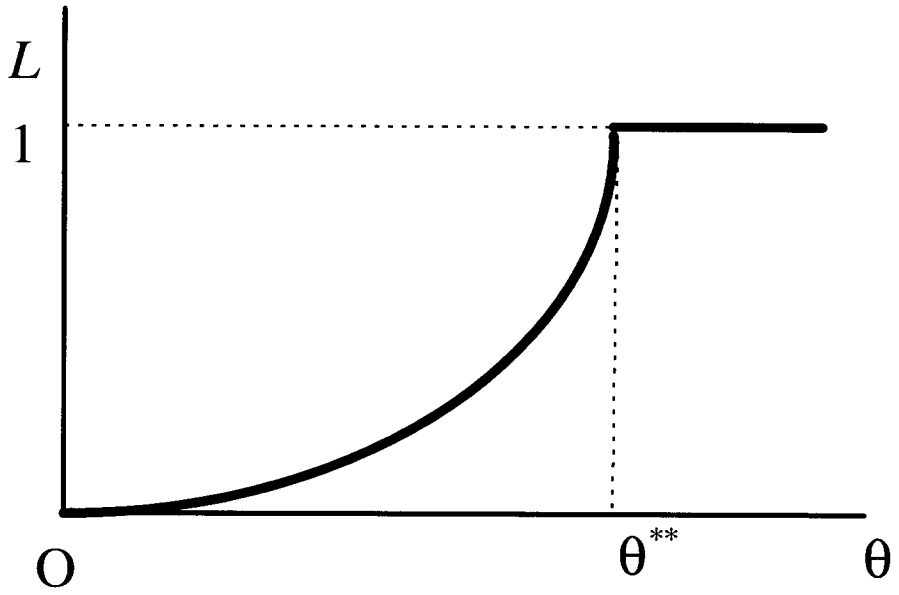

Figure V

Timing with renegotiation

Making contracts: w is determined.

Skill accumulation: c (training cost)

State θ is revealed.

Firm's renegotiation offer: $\tilde{w}$

(if union accepts)
Union determines new resistance policy given $\tilde{w}$: $R(\tilde{L})$
Employment level $\tilde{L}$ is realized.

Production
$\tilde{w}$ is paid to retained employees

Figure VI

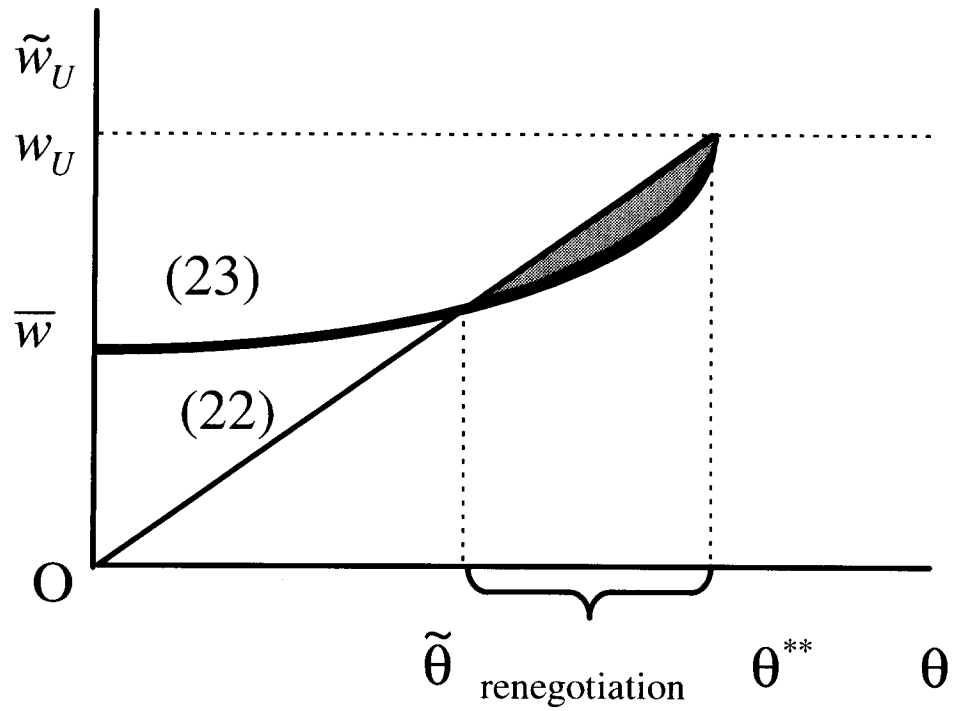
$\tilde{w}_U$
w_U
(23)
$\overline{w}$
(22)
O
$\tilde{\theta}$
renegotiation
θ^{**}
θ

Figure Ⅶ

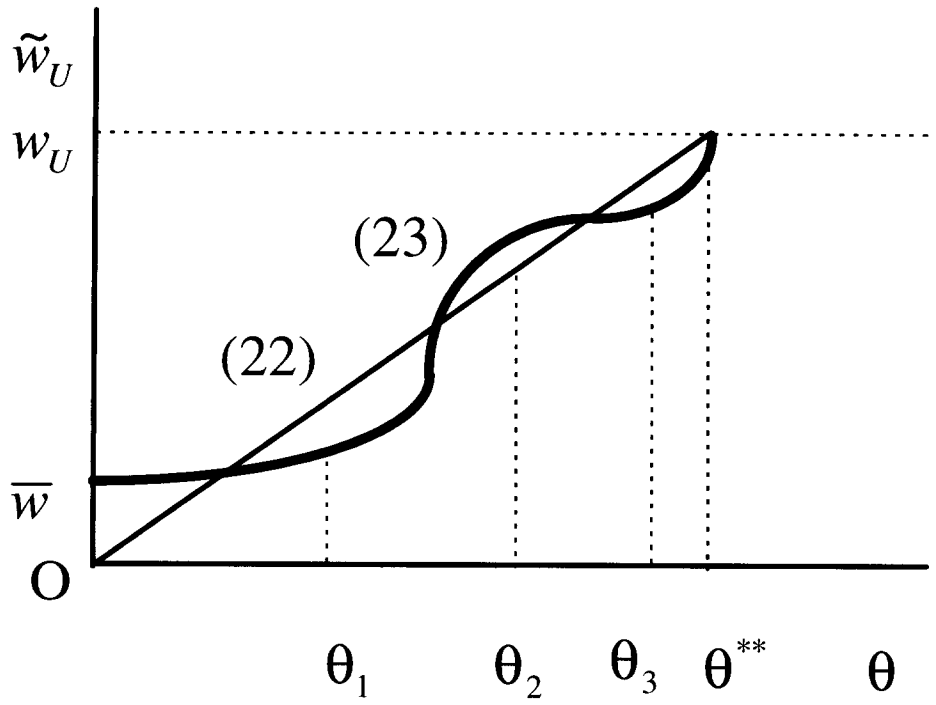
$\tilde{w}_U$
w_U
(23)
(22)
$\overline{w}$
O
θ_1
θ_2
θ_3
θ^{**}
θ

Figure Ⅷ