MINIMUM WAGES ENHANCING TRAINERS' INCENTIVES

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ABSTRACT

I consider the effect of minimum wages to on-the-job training from the viewpoint of trainers' incentives. In the work environment, experienced employees play significant roles in training new employees. However, the more training they provide to trainees, the less likely those trainers would be promoted. I call the trainers' situation the trainers' dilemma between promotion and training. I show that minimum wages alleviate the trainers' dilemma, since minimum wages increase income for not-promoted workers and reduce net benefit of promotion. Hence, minimum wage legislations enhance on-the-job training and social welfare, but reduce firms' profit.

Key Words: Minimum wages, Trainers' dilemma, Promotion, and On-the-job training.
JEL Classification Numbers: J24, J41, K31.

Minimum Wages Enhancing Trainers' Incentives

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1. Introduction

With the perfect competitive market, as Stigler (1946) insisted, minimum wages distort employment and training level in the labor market. Numerous studies have tested the effects of minimum wages, and the results on the effect of minimum wages to training are divided. Recently, some studies provide positive effects of minimum wages. The topic on minimum wages is controversial. In this paper, I focus on an incentive problem of trainers and show another theoretical result such that minimum wages enhance training and improve social welfare.

Rosen (1972) considers long-term human investment and shows that human investment is diminishing with respect to workers' age because old workers have less incentives of human investment. Young workers can use their own human capital for long time to earn high income than old ones, and thus, young workers are willing to make more human investment for themselves. However, the introduction of a minimum wage sets a floor of income and discourages young workers from investing for themselves. Leighton and Mincer (1981) and Hashimoto (1982), following the human capital theory, focus on wage growth as a proxy of training and indicate that minimum wages reduce human capital formation caused by training. However, as studies on wage profiles such as Lazear (1979) (1981), Medoff and Abraham (1980), and Lazear and Moore (1984) show, wage growth is not always identical to human capital formation, and thus, the indirect approach based on wage growth is unsatisfactory. Neumark and Wascher (2001) overcome this problem and show that the hike of minimum wages leads to decline of training opportunities, especially formal training in the U.S. Schiller (1994) also finds a negative effect of minimum wages to training in the U.S.

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Recently, some studies provide counter-results on the effect of minimum wages. Acemoglu and Pische (2003) extend their previous study (Acemoglu and Pixche (1999)) and theoretically show that minimum wages enhance training for workers with low income. They also find that minimum wages have no empirically significant effect to training in the U.S. Grossberg and Sicilian (1999) also discover that minimum wages have no significant impact on training although it reduces the wage growth in the U.S. that has been used as a proxy of human capital formation.

In the U.K., the minimum wage law came into force in April 1999, and hence, the experience in the U.K. is an effective and appropriate object for testing the effects of the minimum wage legislation. Arulampalam, Booth and Bryan (2003) (2004) show that the minimum wage legislation in the U.K. increases the incidence of training for workers with low income by 8 %, and does not affect the training for workers with high income, who are not directly influenced by the introduction of the minimum wage.

As we mentioned above, these empirical works have provided different findings on the effect of minimum wages to training.[1] Hence, some studies have tried to explain how minimum wages enhance training and improve social welfare. If the labor market is perfect and there is no market failure, as Hashimoto (1982) shows, free trade leads to efficiency in the labor market, and thus, any regulation like minimum wages never provides positive impact to the economy. Therefore, if minimum wages improve social welfare, it is the cases of market failures.[2]

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[1] The effect of minimum wages to employment level is also diverse. Deere, Murphy and Welch (1995) find that the hike of the minimum wages in 1990 and 1991 reduces employment for male teenage workers by 15% and female teenage workers by 12% in the U.S. However, Stewart (2004a) (2004b) indicates that the minimum wage legislation does not influence a significant effect to employment level in the U.K.

[2] Minimum wages can increase employment level and social welfare in the case of imperfect market and market failure. As Stigler (1946) mentioned, one case is monopsony. In this case, the firm faces increasing marginal expenditure with employment, and hence, the firm is unwilling to employ workers sufficiently. Since the introduction of a minimum wage can make the firm face a constant lower marginal expenditure, the minimum wage can increase employment level and improve social welfare.

Lang (1987) considers an adverse selection case and shows that minimum wages can increase employment level. A firm has to require high education and pay higher wage to workers with high ability for self-selection in order to prevent workers with low ability from pretending workers with high ability. The introduction of a minimum wage discourages workers with low ability from pretending having high ability since workers with low ability can get comparatively high wage under

Acemoglu and Pische (2003) theoretically point out that minimum wages encourage firms to provide training of general skills for young workers with low income. Minimum wages increase the wage of young or less ability workers, and then the amount of payment that firms have to pay is independent of training. For simplicity, a firm's benefit from the training of general skill is denoted as $B(t^*) = b + f(t^*) - w(t^*) - c(t^*)$, where t^* means the amount of training and b is the rent that the firm gets from the imperfectness of labor market or the firm-specific skill formation. $f(t^*)$, $w(t^*)$ and $c(t^*)$ mean productivity, payment and the training cost, respectively. From the Becker's theorem on the general skill formation (Becker (1964)), it holds that the free perfect competition after the training leads to $f(t^*) = w(t^*)$, and thus, the firm has no incentive of the training: $t^*=0$. However, the introduction of a minimum wage eliminates the relationship of no profit on the general skill formation: $B(t^*) = b + f(t^*) - \overline{w} - c(t^*)$, where $\overline{w}$ is the minimum wage. In this situation, the firm is willing to invest for workers even if the minimum wage reduces the firm's profit due to $\overline{w} > w(t^*) = f(t^*)$. The optimal training is given by $t^* \equiv \arg\max f(t^*) - c(t^*)$. This is the essence of Acemoglu and Pische (2003) that minimum wages enhance training.

Agell and Lommerud (1997) consider an adverse selection case with the contractual incompleteness to show that minimum wages can increase educational investment (schooling). They are concerned that workers get income through Nash bargaining. Since the introduction of a minimum wage improves workers' threat point in the stage of Nash bargaining, workers can get more income, and thus, this effect encourages workers to make more educational investment. However, firms are discouraged from making the specific investment. If the former positive effect dominates the latter negative one, minimum wages increase educational investment.

Although these models are interesting, they pay much attention on the general skill formation or educational investment. In this paper, we focus on trainers' incentives for on-the-job training. It is often the case that trainers and trainees are co-workers, particularly in the case of on-the-job training because the skills accumulated in this manner are difficult to acquire elsewhere, such as in the classroom. Doeringer and Piore (1971, p. 20) pointed out, "For certain jobs there is no alternative to training on the job.

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the minimum wage regime. As the result of the introduction of a minimum wage, the firm can lower payment cost and increase employment. This is a positive effect of minimum wages. Rebizer and Taylor (1995), following the efficiency wage model, consider the case that workers' productivity increases with wage, and show that minimum wages can reduce firms' profit, but improve employment and welfare.

These jobs exist only as work performed and cannot be duplicated in the classroom. Incumbent employees have difficulty describing or demonstrating the skill they possess, except in a production context." In that situation, experienced workers play significant roles of training new trainees who are also co-workers, which can lead to rivalry between trainers and trainees when competing for promotion.

Promotion competitions as rank order tournaments that Lazear and Rosen (1981), Green and Stokey (1983), and Nalebuff and Stiglitz (1983) analyzed are often observed in the real world. Thus, we have a problem: What are the incentives for trainers to instruct trainees, which benefits the trainees to the detriment of the trainer himself? We call this problem the trainers' dilemma between training and promotion. Outside schooling can sometimes be useful for firm-specific skills, however, as Doeringer and Piore (1971) and Koike (1977) insist, on-the-job training is often more significant for formation of these specific skills, and experienced workers are generally expected to assist and instruct new employees. Hence, it is in the case of the specific skill formation that we would likely see the trainers' dilemma between training and promotion. There is a major problem with firms encouraging experienced workers to provide effective assistance for young workers. For example, the Insider-Outsider theory by Lindbeck and Snower (1988) focuses on the opportunistic behaviors of experienced workers and considers the effect of these behaviors on wage and unemployment. This means that roles of experienced workers are crucial in the real world.

As Itoh (1994) points out, an answer to this trainers' dilemma may be found by separating older workers as trainers from younger workers as trainees in the promotion competition. If firms can commit to treating generations of workers separately in terms of promotion, then the experienced workers doing the training would not worry about losing out to the younger workers in the promotion competition and should then be willing to devote their time and skills to the training process. Reagan (1992) indicates that compensating job security based on the seniority rule has the same effect on training. Eguchi (2004) shows that fostering of workers with multiskills can alleviate the trainers' dilemma, and thus, increase training and welfare.

Unfortunately, however, most firms cannot commit to that separation and are more willing to promote able, young, highly productive workers rather than the older, less productive employees. Actually, relying on seniority as a means of promotion is rarely used today except for some blue collar jobs in the U.S, and therefore, at most firms, young, talented employees tend to be promoted faster than older ones with less ability when the age difference between older and younger is small. Furthermore, Shaeffer (1983), Rosenbaum (1984), Forbes (1987), and Sheridan *et al* (1990) observed a fast-track

promotion system for manager candidates in U.S. firms. Since firms are unlikely to promote the older workers with lower productivity, as these trainers devote more time and energy to trainees and less to their own tasks, they decrease their odds for promotion. Thus, firms must offer these older workers a high payment as incentive for their contribution as trainers.

The trainers' dilemma is caused by high promotion prize that promoted workers receive. If the promotion prize does not exist, the trainers' dilemma disappears. The introduction of a minimum wage increases income for not-promoted trainers and reduces the net promotion prize for trainers, and thus, the minimum wage softens the trainers' dilemma. Hence, firms can encourage trainers by lower compensation for training although firms have to pay wage more than, at least equivalent to, the minimum wage. Therefore, minimum wages enhance training and improves social welfare.

Furthermore, I consider the case that non-promoted workers are fired and have some difficulty of getting new jobs due to minimum wages. Decline of employment in the labor market caused by minimum wages is crucial to welfare. The hike of minimum wages can make fired workers' environment worse. This is a negative effect. The impact of the hike of minimum wages depends on the difference between the latter negative effect and the former positive one that I have mentioned. However, when the level and the hike of minimum wages are moderate, training and welfare are enhanced. In this situation, minimum wages alleviate the trainers' dilemma between training and promotion and enhance training and welfare.

In the chapter 2, I set up a basic model to show that minimum wages alleviate the trainers' dilemma between training and promotion and enhance training and welfare, but reduce firms' profit. In the chapter 3, I extend the model to the case that non-promoted worker is fired and has some difficulty of getting a new job. It will be shown that the same results are obtained when the level and the hike of a minimum wage are comparatively moderate. Finally, conclusions are provided in the chapter 4.

2. The Model

I consider a simple model where a firm has a new and an experienced employees and one slot in an upper management rank. An employee with high productivity is promoted to that management job. The experienced employee works as a trainer and a new one as a trainee in the firm in the period 1. The trainer is required to provide effective training to the trainee, and thus, the experienced worker as a trainer provides some

amount of training and increases the productivity of the new worker as a trainee.

When the trainee receives informal on-the-job training and help from the trainer, the trainee's productivity T in the management position is followed by

$$T = t + \varepsilon,$$

where the amount of help provided by the trainer to the trainee is denoted as t, and his potential ability as ε. The help of training t devoted to the trainee is non-negative. Although the distribution function $\Phi(\varepsilon)$ of the trainee's potential ability is known, the trainee's ability ε is unknown to everyone including the trainee during training. For simplicity, we focus on the case of uniform distribution: $\varepsilon \sim U[\underline{\varepsilon}, \overline{\varepsilon}]$, where $\overline{\varepsilon} \ (>0)$ is sufficiently large. The density function is given by $\phi(\varepsilon) = \dfrac{1}{\overline{\varepsilon} - \underline{\varepsilon}} \equiv z$.

The trainee's productivity T is verifiable, but the amount of training t and the trainee's ability ε are not separately observed by a firm manager. Hence, the firm manager offers an incentive payment scheme conditional on the trainee's productivity, but she cannot make a contact contingent on the amount of training. As I show later, the trainer is assumed to be risk neutral. Since the trainer's utility depends only on the expected wage, it is not influenced by shapes of wage schemes. Hence, it is sufficient to consider a simple wage scheme as follows:

$$w(T) = \begin{cases} \overline{w} + b & if \quad T \geq T^* \\ \overline{w} & if \quad T < T^* \end{cases}. \qquad \qquad \dots(1)$$

A minimum wage is given by $\overline{w}$ and compensation for the informal training is denoted as b. The compensation for the training is a kind of bonus for the trainer. He can receive it when the trainee's productivity is more than a critical point T^*. The firm manager specifies the bonus b of the training and the critical point T^* in the contract. The minimum wage is exogenously given by the government.

The trainer's productivity is a constant and given by $\overline{T}$. After the trainee's productivity T is revealed, either the trainer or the trainee is promoted to the upper rank in the firm. If $T \leq \overline{T}$, the trainer wins the promotion competition and is promoted; however, if $T > \overline{T}$, he loses. Hence, when the trainer provides the amount of training t, he is promoted with the probability $\Phi(\overline{T} - t)$.

The winner of the promotion competition receives promotion payment v. There is a constraint on the promotion payment the firm faces: $v \geq \overline{v} \ (>0)$. The constraint of

the promotion payment $\bar{v}$ is an exogenously given by labor market pressure the incumbent firm faces. Although the incumbent firm may know its own employees' productivity, outside firms are unable to observe their ability. Since the very able employees tend to be promoted, promotion provides additional signals for outside firms on the promoted employees' abilities. Hence, outside firms are willing to extract the promoted employees from the incumbent firm. With labor market pressure like this, the incumbent firm must, at the least, offer a positive level of promotion payment $\bar{v}$ to discourage the promoted employees from quitting the firm.[3]

      The timing of the players is given as follows:

1) The firm manager offers an incentive compatible payment scheme with the trainer. A bonus of training and the critical point T^* are specified in the scheme.
2) The trainer makes a decision on the amount of training for his trainee.
3) After the training, the trainee's productivity is revealed. An employee with higher productivity, either the trainer or the trainee, is promoted to the upper management position and gets the promotion payment v. The other employee with lower productivity is not promoted, retains in the lower rank, and get the minimum wage $\bar{w}$.

The trainer's expected utility is given by

$$U(t) \equiv \bar{w} + b(1 - \Phi(T^* - t)) - c(t) + \bar{w} + \Phi(\bar{T} - t)(v - \bar{w}), \qquad \ldots(2)$$

where $c(t)$ is a training cost function satisfied as follows:

$$c' > 0 , \ c'' > 0 , \ c(0) = 0 , \ and \ c'(0) = 0. \qquad \ldots(3)$$

In the period 1, the trainer gets the minimum wage and the bonus conditional of the productivity of the trainee, but he bears the training cost. In the period 2, the trainer gets the minimum wage and the net promotion prize $v - \bar{w}$ when he is promoted.[4] The

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[3] Waldman (1984) and Ricart I Costa (1988) analyzed how the extraction of workers by outside firms distorts both promotion speed and the range of employees' abilities under asymmetric information on employees' abilities between the incumbent and outside firms. Gibbons and Katz (1991) considered which type of worker is likely to be fired in a similar situation.

[4] At the moment, I consider the case that the trainer or the trainee retains in the incumbent firm even if one of them is not promoted. Later, I consider the case that a not-promoted worker is fired, and show

assumption of $v > \overline{w}$ is reasonable because wage in the upper rank is almost always more than the minimum wage.[5] Payment of the bonus depends on the critical point T^* and the promotion prize is subject to the trainer's productivity $\overline{T}$. $\overline{T}$ is given and T^* is determined by the firm. T^* can be more or less than $\overline{T}$.

The trainer chooses the amount of training to maximize his expected utility given the wage scheme and the critical point. The first order incentive compatibility is given by

$$\text{IC:} \quad t^* \equiv \arg\max_t \overline{w} + b(1 - \Phi(T^* - t)) - c(t) + \overline{w} + \Phi(\overline{T} - t)(v - \overline{w}).$$

From the first order condition, given the wage scheme and the critical point, the amount of training is determined by

$$b = \frac{c'(t^*)}{z} + v - \overline{w}. \qquad\qquad \text{…(4)}$$

The amount of training provided by the trainer is dependent on the bonus b and the net promotion prize $v - \overline{w}$. As the bonus of training increases or the net promotion prize reduces, the trainer is willing to provide more training. Increase of the net promotion prize discourages the trainer from providing training. Increase of the minimum wage reduces the net promotion prize, and thus, it alleviates the trainer's dilemma and enhances training. As we show later, this effect is crucial.

Next, we consider individual rationality (IR). The trainer retains in the two periods in the firm. The period 1 is for training, and the period 2 is for working on the upper rank or the lower rank. Since the firm has to compensate the minimum wage, individual rationality for the trainer is as follows:

$$\text{IR:} \quad U(t^*) \equiv \overline{w} + b(1 - \Phi(T^* - t^*)) - c(t^*) + \overline{w} + \Phi(\overline{T} - t^*)(v - \overline{w}) \geq 2\overline{w}.$$

Note that the trainer receives the minimum wage at least in each period. Now, we are concerned that the non-promoted trainer is not fired and receives the minimum wage in

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that the same result is obtained under the moderate hike of minimum wages.

[5] If $v \leq \overline{w}$ holds, the trainer's dilemma between training and promotion disappears. In this situation, the tradeoff relationship between the compensation for training and promotion prize does not exist.

the lower rank. The firm minimizes the payment cost, and thus, individual rationality is always binding at the equilibrium. Thus, the above IR is replaced by

$$b(1 - \Phi(T^* - t^*)) = c(t^*) - \Phi(\overline{T} - t^*)(v - \overline{w}) . \qquad \qquad \dots(5)$$

For simplicity, we assume that the training program is not productive. Hence, the firm receives two employees' contribution after the training and the determinant of promotion. Since an employee with higher productivity is promoted, the trainer is promoted with the probability $\Phi(\overline{T} - t^*)$ and the trainee is promoted with probability $1 - \Phi(\overline{T} - t^*)$. The expected productivity in the upper rank is as follows:

$$y^{upper} \equiv \int_{\underline{\varepsilon}}^{\overline{\varepsilon}} \max\{\overline{T}, T\} \phi(\varepsilon) d\varepsilon = \Phi(\overline{T} - t^*)\overline{T} + \int_{\overline{T} - t^*}^{\overline{\varepsilon}} (t^* + \varepsilon)\phi(\varepsilon) d\varepsilon.$$

The non-promoted employee works in the lower rank in the period 2. The task in the lower rank is simple, and thus, professional skills and ability are irrelevant to the lower rank. The contribution of an employee in the lower rank is a constant y. Total output is given by $Y \equiv y^{upper} + y$. Total expected payment cost the firm bears is as follows. The trainer gets the expected earning $\overline{w} + (1 - \Phi(T^* - t^*))b$ and the trainee only gets the minimum wage $\overline{w}$ in the period 1. After the training, the promoted employee receives v in the upper rank and the non-promoted employee gets the minimum wage $\overline{w}$ in the lower rank. Thus, the firm's expected profit is given by

$$\Pi \equiv Y - 3\overline{w} - v - (1 - \Phi(T^* - t^*))b . \qquad \qquad \dots(6)$$

Now, I have set up my model to consider the optimal amount of training. Introducing (5) into (6), the firm's profit is given by $\Pi = Y - 3\overline{w} - v - c(t^*) + \Phi(\overline{T} - t^*)(v - \overline{w})$. Since it holds that $\dfrac{\partial \Pi}{\partial v} = -(1 - \Phi(\overline{T} - t^*)) < 0$, the firm is willing to offer the minimum promotion payment: $v = \overline{v}$. The assumption of $\overline{v} > \overline{w}$ is kept and is consistent with the observed fact that workers with high productivity who are promoted to the upper rank or the management position get higher wage in the real world.

Differentiating the firm's profit with respect to t^*, the first order condition is obtained as follows:

$$\frac{\partial \Pi}{\partial t*} = 1 - \Phi(\overline{T} - t*) - c'(t*) - z(\overline{v} - \overline{w}) = 0. \qquad \dots(7)$$

I define the function $F(t)$ from the first order condition of t as follows: $F(t) \equiv 1 - \Phi(\overline{T} - t) - c'(t) - z(\overline{v} - \overline{w})$. From (3), $F(t) \to -\infty$ as $t \to +\infty$. Since $F'(t) = z - c''$ holds, $F'(t)$ is a strictly decreasing function of t. When a positively and globally optimal solution $t*$ exists, the function $F(t)$ is strictly decreasing at $t = t*$. $F(t)$ is like figure 1, and hence, the second order condition strictly holds: $\frac{\partial^2 \Pi}{\partial t*^2} < 0$.

From (4), the bonus b is identically corresponded to the amount of training $t*$. Determinant of $t*$ leads to that of b simultaneously. After the determinant of b and $t*$, the critical point $T*$ is determined from (5). Thus, the endogenous valuables, b, $t*$ and $T*$ are optimally determined.

Proposition 1

The hike of the minimum wage increases the amount of training and social welfare, but reduces the firm's profit.

Proof is easy. Differentiating (7) with respect to $t*$ and $\overline{w}$,

$$\frac{\partial^2 \Pi}{\partial t*^2} dt* + \frac{\partial^2 \Pi}{\partial t* \partial \overline{w}} d\overline{w} = 0.$$

Using the second order condition $\frac{\partial^2 \Pi}{\partial t*^2} < 0$ and $\frac{\partial^2 \Pi}{\partial t* \partial \overline{w}} = z > 0$, it holds that

$$\frac{dt*}{d\overline{w}} > 0. \qquad \dots(8)$$

Using the envelop theorem, the effect of the hike of the minimum wage to the firm's profit is given by

$$\frac{d\Pi}{d\overline{w}} = \frac{\partial \Pi}{\partial t*} \frac{dt*}{d\overline{w}} + \frac{\partial \Pi}{\partial \overline{w}} = \frac{\partial \Pi}{\partial \overline{w}} = -3 - \Phi(\overline{T} - t*) < 0. \qquad \dots(9)$$

Social welfare is represented by $W = Y - c(t*)$. Differentiating with respect to $\overline{w}$,

$$\frac{dW}{d\overline{w}} = \left\{ 1 - \Phi(\overline{T} - t^*) - c'(t^*) \right\} \frac{dt^*}{d\overline{w}}. \qquad \qquad \text{...(10)}$$

From (7) and (8), it holds that

$$\frac{dW}{d\overline{w}} > 0. \qquad \qquad \text{...(11)}$$

Therefore, from (8), (9) and (11), the hike of the minimum wage increases training and social welfare, but reduces the firm's profit.

The trainer faces the dilemma between training and promotion. If the trainer provides much amount of training, he is unlikely promoted. This effect discourages the trainer from instructing the trainee. Hence, the firm has to offer a sufficient compensation for training to give incentives of training to the trainer. As the first order incentive compatibility (4) implies, the incentive compatible bonus b would be high as the promotion payment v increases. Increase of v means that the opportunity cost of training is large for the trainer. The trainer is likely to miss the high prize of promotion by providing training, and thus, the trainer has less incentive. The firm has to offer a sufficient high bonus to maintain the trainer's incentives to make the trainer provide the same amount of training. However, the hike of the minimum wage alleviates the trainer's dilemma between training and promotion because the hike of the minimum wage reduces the net prize of promotion. This effect decreases the real loss on promotion caused by training. Therefore, the hike of the minimum wage encourages the trainer to provide training.

The existence of the trainer's dilemma lowers the amount of training enforced by the trainer. Increase of the minimum wage alleviates the dilemma and enhances training and social welfare. However, it raises the payment cost and reduces the firm's profit.

3. Extension

I have considered the case that a non-promoted employee retains in the firm in the previous section. However, the minimum wage can be more than his contribution in the lower rank: $y < \overline{w}$. In this situation, the firm is unwilling to employ the non-promoted employee. Now I am concerned that the non-promoted employee is fired

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and how the modification affects the result.

The trainer's expected utility is given by

$$U(t) \equiv \overline{w} + b(1 - \Phi(T* - t)) - c(t) + \Phi(\overline{T} - t)\overline{v} + (1 - \Phi(\overline{T} - t))q(\overline{w})\overline{w}. \quad \dots(12)$$

In the period 1, the trainer gets the minimum wage and the bonus conditional of the productivity of the trainee, but he bears the training cost. In the period 2, the trainer gets the promotion prize $\overline{v}$ only when he is promoted. When he loses the promotion competition, he is fired and searches a new job. Since the minimum wage legislation can distort the labor market, he may not get a new job immediately. The probability to get a new job with the minimum wage is denoted as $q(\overline{w})$. The hike of the minimum wage reduces the probability to get a new job, and thus, the following assumption is given:

$q'(\overline{w}) \leq 0$, $q(0) > 0$ and $\lim_{\overline{w} \to +\infty} q(\overline{w}) = 0$.

From the first order condition, given the wage scheme and the critical point, the amount of training is determined by

$$b = \frac{c'(t*)}{z} + \overline{v} - q(\overline{w})\overline{w}. \quad \dots(13)$$

Next, I consider individual rationality (IR). When the trainer rejects the contract, he is fired and searches a new job. He works for two periods. If he can get a new job immediately, his total utility is $2\overline{w}$. This happens with the probability q. If he fails to search a new job in the period 1, he gets nothing and continues searching a new job in the period 2. When he can find a new job in the period 2, he receives the minimum wage. This happens with the probability $(1-q)q$. Otherwise, he can get nothing for two periods. Hence, individual rationality is given by

$$\overline{w} + b(1 - \Phi(T* - t*)) - c(t*) + \Phi(\overline{T} - t*)\overline{v} + (1 - \Phi(\overline{T} - t*))q\overline{w} \geq (3q - q^2)\overline{w}. \quad \dots(14)$$

The firm minimizes the payment cost, and thus, individual rationality is always binding at the equilibrium. The firm's expected profit is given by $\Pi \equiv y^{upper} - 2\overline{w} - \overline{v} - (1 - \Phi(T* - t*))b$. Introducing (14) to the firm's profit,

$$\Pi = y^{upper} - (1 - \Phi(\overline{T} - t*))\overline{v} - c(t*) + (1 - \Phi(\overline{T} - t*))q\overline{w} - (1 + 3q - q^2)\overline{w}.$$

Differentiating it with respect to $t*$, the first order condition is obtained as follows:

$$\frac{\partial \Pi}{\partial t*} = 1 - \Phi(\overline{T} - t*) - c'(t*) - z(\overline{v} - q(\overline{w})\overline{w}) = 0 . \qquad \ldots(15)$$

Differentiating (15) with respect to $t*$ and $\overline{w}$,

$$\frac{\partial^2 \Pi}{\partial t*^2} dt* + \frac{\partial^2 \Pi}{\partial t* \partial \overline{w}} d\overline{w} = 0 .$$

It holds from the second order condition that $\dfrac{\partial^2 \Pi}{\partial t*^2} < 0$ and $\dfrac{\partial^2 \Pi}{\partial t* \partial \overline{w}} = \{q(\overline{w}) + \overline{w}q'(\overline{w})\} z$.
Hence, it holds that

$$sign \frac{dt*}{d\overline{w}} = sign\{q(\overline{w}) + \overline{w}q'(\overline{w})\} . \qquad \ldots(16)$$

I denote the expected wage that a fired trainer receives as $Q(\overline{w}) = q(\overline{w})\overline{w}$. The effect of the hike of the minimum wage to training depends on the sign of $Q'(\overline{w}) = q(\overline{w}) + \overline{w}q'(\overline{w})$. Clearly, $Q(0) = 0$, $Q'(0) = q(0) > 0$ *and* $\lim_{\overline{w} \to +\infty} Q'(\overline{w}) < 0$. The curve of the function $Q(\overline{w})$ is represented like figure 2. Hence, it holds that $Q'(\overline{w}) > 0$ when $\overline{w}$ is moderate.

Proposition 2
When the level and the hike of the minimum wage are comparatively moderate, it increases training and social welfare, but reduces the firm's profit.

Proof
When the level of the minimum wage is moderate, that is, not huge, it holds that $Q'(\overline{w}) > 0$ because it holds that $Q'(0) = q(0) > 0$. Hence, $\dfrac{dt*}{d\overline{w}} > 0$ holds when the minimum wage is moderate. Social welfare is represented by $W = y^{upper} - c(t*)$. Similarly to (10), it holds that $\dfrac{dW}{d\overline{w}} > 0$ if $\dfrac{dt*}{d\overline{w}} > 0$. Also, using the envelop theorem, the effect of increase of the minimum wage to the firm's profit is given by

$$\frac{d\Pi}{d\overline{w}} = \frac{\partial\Pi}{\partial t^*}\frac{dt^*}{d\overline{w}} + \frac{\partial\Pi}{\partial\overline{w}} = \frac{\partial\Pi}{\partial\overline{w}} = -q(3-q) - \left\{1 - (1 - \Phi(\overline{T} - t^*))q\right\} < 0 \, ,$$

the firm's profit reduces.∎

When the hike of the minimum wage reduces the probability to get a new job drastically, the hike would make the trainer's environment worse. $Q'(\overline{w}) < 0$ means that the hike of the minimum wage makes the trainer's dilemma more serious. Hence, the trainer is discouraged, and thereby training and welfare reduce. However, when the level and the hike of the minimum wage are moderate, it holds that $Q'(\overline{w}) > 0$. This means that the minimum wage alleviates the trainer's dilemma, and thus, enhances training and welfare. It is intuitive that the big hike of the minimum wage does a serious damage to the economy. However, if the hike is moderate, it improves training and welfare although it reduces the firm's profit.

4. Conclusion and Discussion

I have paid much attention to trainers' incentive and shown that minimum wages increase the amount of training and social welfare, but reduce firms' profit. The hike of minimum wages reduces the net promotion prize, and thus, alleviates the trainer's dilemma between promotion and training. Hence, firms do not have to pay high compensation for training, and the effect enhances training and social welfare.

It is pointed out that upward wage profiles, delayed payment schemes, are effective devices for firm-specific skill formation. Delayed payment schemes are kinds of "hostage" for workers, and thereby, the devices can make employees work hard. Although younger employees get lower payment than their contribution, aged employees can receive higher payment than their contribution. If young employees shirk, they are likely fired and do not get back their "hostage". Hence, they are willing to learn the firm-specific skills.

If minimum wage legislations are introduced under the delayed payment schemes, "hostage" can be small. This can be a negative effect to workers' incentives. Note that this is an impact on trainees' incentives for training. In this paper, we have considered trainers' incentives. Minimum wage legislations can discourage trainees' incentives, but encourages trainers' incentives. Neumark and Wascher (2001) find that

minimum wage legislations do serious damages to formal training, however, does not provide significant effect to informal training. Firm-specific skill formation through on-the-job training is likely be done informally while employees work. My result is not necessarily inconsistent with the empirical finding.

Since minimum wages reduce firms' profit, minimum wages can make firms quit form the market and reduce job opportunities for a long time. This is a negative effect to welfare. Although this effect should be empirically tested, we can raise some papers mentioning that the negative effect can not be serious. Ippolito (2003) focuses on the workers' search behaviors to get job opportunities and mentions that minimum wages have little significant effect in the labor market. Dickens and Lang (1985) find that most of workers belong to the primary sector, and therefore, as Lang (1987) mentions, the negative effect can be less than the positive effect that enhances training. In the chapter 3, I have considered the case that minimum wages reduces job opportunities in the labor market and shown that the level and the hike of minimum wages can enhance training and welfare.

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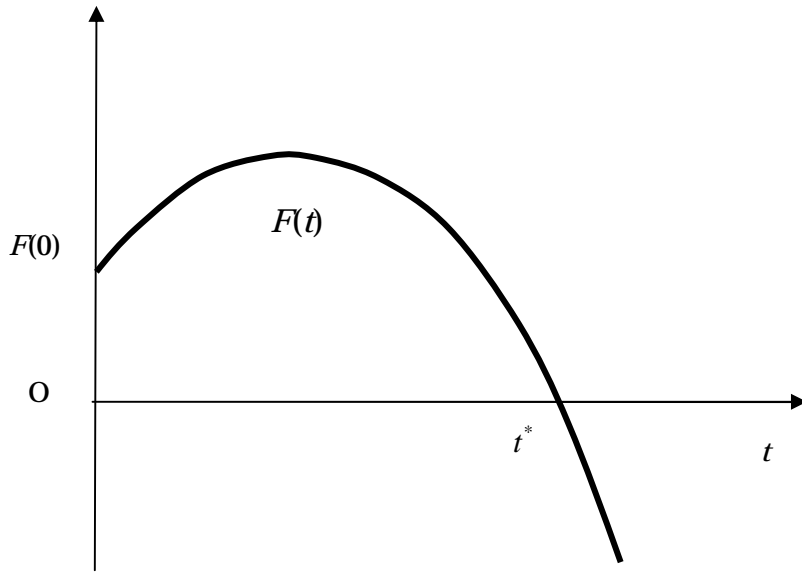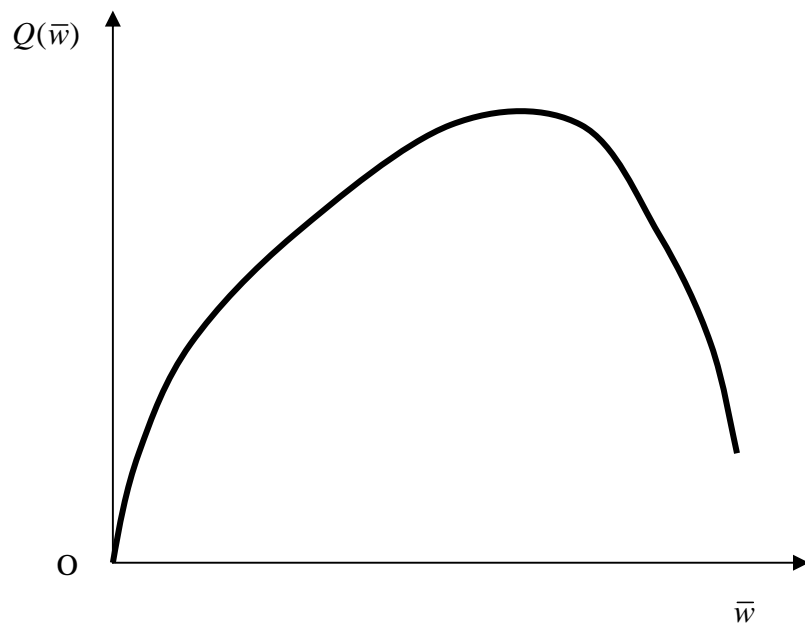 *Rand Journal of Economics*, 15, 255-267.

Figure 1

Figure 2