Mortensen-Pissarides matching model can hardly explain the volatility of unemployment and vacancies, and Hall (2005) shows that introducing wage rigidity in the model improves its suitability. While Mortensen and Nagypal (2007) and Pissarides (2007) admit that wage rigidity improves the power of explanation of the model, they indicate that the presence of wage rigidity in the model is not essential. According to them, the power of explanation improves if other factors such as hiring or firing costs, demand shocks, and on-the-job search behavior are considered in the typical model. In addition, as Kennan (2006), Moen and Roser (2007), and Brugemann and Moscarini (2007) show, asymmetric information like adverse selection and moral hazard magnify the volatility in unemployment and vacancies. Although the controversial topic of volatility is not discussed in this paper, it is crucial to consider the effects of EPL on the incentives of workers under *ex post* wage inflexibility.

This paper is organized as follows. Section 2 presents a Mortensen-Pissarides matching model with an incentive problem. In section 3, the search equilibrium is introduced and we consider the effects of SP and PI as EPL. We also conduct numerical illustrations to investigate the effects of SP and PI in section 4. Finally, the conclusions are provided in section 5.

2. The Model

1. Employment contract

A firm with a job vacancy is randomly matched to an unemployed worker in the labor market with search friction. An employed worker is required to make efforts to achieve high productivity, and the effort cost c is borne by the employee. The productivity p of an employee who made efforts is stochastically distributed: $p \in [0, \bar{p}]$. The density and distribution functions are denoted as $\phi(p)$ and $\Phi(p)$, respectively. If an employee is shirking, the density and distribution functions are denoted by $\phi^S(p)$ and $\Phi^S(p)$, respectively. The effort cost of a shirking employee is zero. The first order stochastic dominance holds: $\Phi(p) \leq \Phi^S(p)$ for $p \in [0, \bar{p}]$, with strict inequality for a set of values of p with possible probability.

A basic wage is specified only when a firm is matched to a worker. The wage is not conditional on a worker's behavior or his/her productivity p, and it is not flexible after the basic wage level is specified. This setting is identical to the efficiency wage model of Shapiro and Stiglitz (1984).

Timing of behaviors by a worker and a firm is as follows:

(1) When a firm is matched to a worker in the labor market with search friction, a wage w is specified.

(2) The risk-neutral worker chooses whether or not to make an effort. If he/she makes an effort, he/she bears the effort cost c.

(3) If the worker makes an effort, his/her productivity $p \in [0, \bar{p}]$ is followed by the distribution function $\Phi(p)$. If the worker is shirking, his/her productivity is followed by the distribution function $\Phi^S(\hat{p})$.

(4) The firm takes a decision regarding dismissal after revelation of productivity p. If an employee is fired, he/she receives severance pay (SP), is transferred to the unemployment pool, and gets reservation wage $\bar{w}$. The firm that fired the employee turns to a job vacancy in the labor market. On the other hand, if a worker retains employment in the firm, he/she works and produces the output with the value p and receives wage w.

(5) In the next period, the fired worker and the firm that dissolved the match search for a new job match in the labor market. On the other hand, the employee and the firm that maintain the match repeat the same process: the employee chooses whether or not to make efforts, and then, the value of his/her productivity is stochastically determined. The productivity is independent of the past.

2. Employment protection legislation

When a firm fires an employee, the firm bears a firing cost f. After p is revealed, the firm's current profit is $p - w$ if the firm maintains the match, or $-f$ if the firm fires the employee.

The firing cost f borne by the firm consists of two factors: $f = s + z$, where (i) z denotes procedural inconveniences (PI) such as administrative costs for notification and certification or negotiation with unions, and (ii) s denotes monetary transfers such as severance pay (SP). PI is a social wasteful transaction cost, while SP is always given to all fired employees even if they are shirking. Thus, SP and PI are social rules and are exogenously determined by the government.

3. Matching technology

The matching function of Mortensen and Pissarides is given by $m = m(u, v)$, where u is the unemployment rate, and v is the number of vacant jobs as a fraction of the labor force, which is referred to as the vacancy rate. The vacancy-unemployment ratio v/u, or v-u ratio, is denoted as θ. The v-u ratio indicates the market tightness. The matching function is assumed to be a constant return to scale, that is, $q(\theta) \equiv m\left(\frac{u}{v}, 1\right)$, where $q(\theta)$ denotes the probability that a job vacancy will be matched to an unemployed worker. Clearly, $q'(\theta) \leq 0$. Similarly, the probability that the unemployed worker will be matched to a job vacancy is given by $\theta q(\theta)$.

In the labor market, all unemployed workers are considered identical regardless of their past behavior, since their past behavior is not noted in the market. Hence, the matching probability is equivalent among the unemployed. Similarly, all job vacancies in the market are identical for the unemployed.

4. Incentive compatibility

As we show later, an employee is fired in the case of $p \in [0, \hat{p})$, where the threshold $\hat{p}$ is endogenously determined. The probability that a diligent worker who made efforts is fired is denoted by $\Phi(\hat{p})$. If a diligent worker is fired for low productivity, he/she receives SP from his/her firm and is transferred to the unemployment pool. His/her expected current payoff is given by $\Phi(\hat{p})(s+\overline{w})+(1-\Phi(\hat{p}))w-c$.

If an employee is shirking, he/she is fired with the probability $\Phi^S(\hat{p})$. The expected current payoff of a shirking employee is $\Phi^S(\hat{p})(s+\overline{w})+(1-\Phi^S(\hat{p}))w$. Since the court cannot distinguish between a diligent employee and a shirking one, a firm has to pay SP even to a shirking employee.

The present-discounted value of the payoff of a diligent and shirking employee is denoted as E^N and E^S, respectively. Since an employee can decide whether or not to make efforts, the present-discounted value of an employee is given by $E \equiv \max\{E^N, E^S\}$. We consider a discrete-time model, and thus, the present-discounted value of a diligent employee's payoff is as follows:

$$E^N = \Phi(\hat{p})(s+\overline{w})+(1-\Phi(\hat{p}))w-c+\frac{1}{1+r}\{\Phi(\hat{p})U+(1-\Phi(\hat{p}))E\}, \qquad \text{...(1)}$$

where r is the time preference rate and U is the present-discounted value of the payoff to the unemployed. Similarly, the present-discounted value of a shirking employee's payoff is given by

$$E^S = \Phi^S(\hat{p})(s+\overline{w})+(1-\Phi^S(\hat{p}))w+\frac{1}{1+r}\{\Phi^S(\hat{p})U+(1-\Phi^S(\hat{p}))E\}. \qquad \text{...(2)}$$

Finally, the present-discounted value of the unemployed is as follows:

$$U = \bar{w} + \frac{1}{1+r}\{\theta q(\theta)E + (1-\theta q(\theta))U\}, \qquad \text{...(3)}$$

where the wage in the outside market $\bar{w}$ indicates the wage of temporary jobs or the value of leisure. The probability of an unemployed person obtaining a job is $\theta q(\theta)$.

The incentive compatibility (IC) and individual rationality (IR) are given by $E^N \geq E^S$ and $E \geq U$, respectively. The wage w should be more than the reservation wage $\bar{w}$; otherwise any worker will be unwilling to search for a new job. It holds from $w > \bar{w}$ that $E^S > U$, because an employee receives the higher wage w or the reservation wage $\bar{w}$ with severance pay s. This means that $E \geq U$ always holds as long as $E^N \geq E^S$ holds. Therefore, it is sufficient to focus on the constraint $E^N \geq E^S$.

The following condition is introduced on the basis of $E^N \geq E^S$ and $E \geq U$:

$$IC(w) \equiv \left(\frac{(r+\theta q(\theta)+1)(w-\bar{w}) - (r+\theta q(\theta))s}{r+\theta q(\theta)+\Phi^S(\hat{p})}\right)(\Phi^S(\hat{p}) - \Phi(\hat{p})) \geq c. \qquad \text{...(4)}$$

If constraint (4) is satisfied, the incentive compatibility (IC) and the individual rationality (IR) hold. Since the firm is willing to minimize the wage, *IC* (*w*) is binding at the equilibrium.

5. Dismissal

Next, we consider the model from the perspective of the firm. The present-discounted value *J* of a firm matched to a worker is as follows:

$$J = -\Phi(\hat{p})f + \int_{\hat{p}}^{\bar{p}}(p-w)\phi(p)dp + \frac{1}{1+r}\{\Phi(\hat{p})V + (1-\Phi(\hat{p}))J\}.$$

The present-discounted value *V* of a job vacancy is $V = -k + \frac{1}{1+r}\{q(\theta)J + (1-q(\theta))V\}$, where k is job vacancy cost. Since it holds that $V = 0$ from the free entry and exit condition on job vacancies, we obtain $J = \frac{(1+r)k}{q(\theta)}$. Further, $\tilde{J}$ is defined as $\tilde{J} \equiv \frac{J}{1+r}$ such that

$$\tilde{J} = \frac{1}{r+\Phi(\hat{p})}\left\{\int_{\hat{p}}^{\bar{p}} (p-w)\phi(p)dp - \Phi(\hat{p})f\right\} \quad \left(= \frac{k}{q(\theta)}\right). \qquad ...(5)$$

A firm matched to a worker is willing to maximize the present-discounted value *J*. If a firm fires an employee, the present-discounted profit is $-f$ given that $V = 0$. On the other hand, if the firm maintains the match, it is given by $p - w + \frac{k}{q(\theta)}$. Hence, the threshold is given by

$$\hat{p} = w - f - \frac{k}{q(\theta)}. \qquad ...(6)$$

The threshold depends on the wage and the firing cost. A decrease in wage or increase in the firing cost reduces the threshold $\hat{p}$.

The determinant of $\hat{p}$ is based on the *ex post* optimization behavior of the firm because the effort cost of the employee has been sunk. As (6) shows, threshold $\hat{p}$ depends on the wage, and thus, the employee and the firm can take the threshold $\hat{p}$ into account upon being matched. Hence, a firm minimizes the wage subject to (4) and (6).

The threshold $\hat{p}$ must be positive for the employee's incentive: $\hat{p} > 0$. Suppose that $\hat{p} = 0$ holds. In this case, an employee is never fired. The absence of a threat of dismissal induces an employee to shirk, and thus, the IC condition is never satisfied.

6. Beveridge curve

The IC condition in (4), the present-discounted value of a firm's profit (5), and the threshold of dismissal in (6) specify the search equilibrium (θ, w). The job creation rate is given by $\theta q(\theta)\frac{u}{1-u}$, and the job destruction rate is $\Phi(\hat{p})$. From the steady state condition in terms of job flow, the job creation rate should be equivalent to the job destruction rate, and thus, the equilibrium unemployment rate is given by

$$u = \frac{\Phi(\hat{p})}{\Phi(\hat{p}) + \theta q(\theta)}. \qquad ...(7)$$

This is the Beveridge curve.

7. A benchmark: Wage flexibility

Here, as a benchmark, we consider the typical model with wage determination through Nash bargaining before analyzing our model. The wage of a match is determined as the Nash bargaining solution after the productivity of a match is revealed. It holds that $w^* = \arg\max (E-U)^{\beta}(J-V)^{1-\beta}$, where the bargaining power of an employee is denoted by β. In the Nash bargaining solution, the decision to terminate the employment relationship is *ex post* efficient. The wage level of an employee is flexibly adjusted.

According to the search theory textbook of Pissarides (2000, ch.9), in the absence of an incentive problem, the effects of firing taxes that are considered to be PI to the search equilibrium in our model are as follows. The introduction of firing taxes distorts decision making regarding the termination of a match, thereby reducing the entire expected payoff of a match. Since this effect discourages firms from entering the market, market tightness is reduced. This effect is represented as the clockwise rotation of JC in Figure 1. Moreover, firing taxes deter firms from firing employees; thus reducing the threshold of dismissal. This effect makes the Beveridge curve move inward. The entire effect of firing taxes is represented in Figure 1 with the equilibrium moving from E_1 to E_2. The effect of firing taxes as EPL on the unemployment rate is ambiguous; however, it is evident that its effect on the vacancy rate is reduced.

3. Search Equilibrium

Although unstable equilibria can exist in our model, it is reasonable to focus on stable equilibria. It is assumed that adjustment of the entry or exit of job vacancies in the market is slower than the wage adjustment in the match. Since a firm is too small to influence market tightness θ, it is willing to minimize the wage given the market tightness subject to the IC condition in (4). Hence, the IC condition in (4) is binding at all times, even if the economy is not in the search equilibrium. The locally stable condition of equilibria is given by

$$IC_w \frac{kq'}{q^2} - IC_\theta \tilde{J}_w < 0, \qquad \text{...(8)}$$

where $IC_w \equiv \dfrac{\partial IC(w^*)}{\partial w}$, $IC_\theta \equiv \dfrac{\partial IC(w^*)}{\partial \theta}$, and $\tilde{J}_w \equiv \dfrac{\partial \tilde{J}}{\partial w}$.

The search equilibrium is given by the point of intersection in Figure 2.[2] The wage offer is adjusted more smoothly than the entry or exit of job vacancies; therefore, the economy is almost always on the curve of the IC condition in (4). In Figure 2, point A on the $IC(w^*) = c$—which is near the equilibrium E_1—is below the JC curve of (5); hence, the expected profit of a job vacancy on point A is positive. Therefore, more job vacancies enter the market. The economy is distant from the equilibrium E_1, therefore, the equilibrium E_1 is unstable. On the other hand, the equilibrium E_2 is stable. Although we do not explicitly consider the transition dynamics, the locally stable condition is given by (8).

First, we consider how the change in the relative impact of SP affects the economy given a constant level of firing cost, that is, $f = \bar{f}$.

Proposition 1

Suppose that the share of SP increases given a constant level $\bar{f}$ of firing cost. The wage increases and the v-u ratio decreases: $\left.\frac{dw^*}{ds}\right|_{f=\bar{f}} > 0$ and $\left.\frac{d\theta}{ds}\right|_{f=\bar{f}} < 0$, respectively. In addition, the threshold of dismissal and the unemployment rate increase: $\left.\frac{d\hat{p}}{ds}\right|_{f=\bar{f}} > 0$ and $\left.\frac{du}{ds}\right|_{f=\bar{f}} > 0$, respectively.

Proof is in the appendix. When the stringency of EPL is fixed, that is, $f = \bar{f}$, a firm bears the same firing cost $f = \bar{f}$ regardless of the share of SP. Since a shirking employee is entitled to receive SP when he/she is fired, SP discourages an employee to put in the required efforts. A higher wage offer is necessary to maintain the employee's incentives, which reduces the firm's profit from the match. This is the *disincentive effect*. It deters firms from entering vacancies into the market, thereby reducing market tightness.

Since the total firing cost does not change, the JC curve of (5) does not move. On the other hand, an increase in the share of SP shifts the curve of the IC condition upward, thereby increasing the wage and reducing market tightness (Figure 3a). Moreover, the job destruction rate depends on the threshold $\hat{p}$, which is pushed up by the increase in wage w and the decrease in market tightness θ. Hence, it becomes clear

[2] Although the IC condition is plotted as a downward-sloping curve in Figure 2, it may be upward-sloping. The slope of the curve is irrelevant to the result only if the stable condition in (8) holds.

that the job destruction rate increases, resulting in an increase in the unemployment rate from (7). The Beveridge curve in (7) moves out owing to the increase in the job destruction rate $\Phi(\hat{p})$. Therefore, the increase in the share of SP shifts the equilibrium from E_1 to E_2 as shown in Figure 3b. Since the market tightness reduces, as Figure 3b shows, the unemployment rate increases unambiguously.

In contrast, if the share of PI increases, the wage reduces and market tightness increases. In addition, the threshold of dismissal and the unemployment rate reduce.

4. Numerical Illustration

The results of proposition 1 hold when the total firing cost is fixed. In this chapter, we proceed from a limited case to a general case. Unfortunately, the total effect is ambiguous from the theoretical perspective. Hence, we conduct a numerical illustration of the search equilibrium.

The equilibrium is characterized by the IC condition in (4) and the zero profit condition of a vacancy in (5) along with the threshold in (6). A base line situation is given in Table 1. We consider the case in which productivity is uniquely distributed, that is, $\phi(p) \equiv \frac{1}{\bar{p}} = \frac{1}{100}$. Furthermore, the productivity density function of a shirking employee is given by $\phi^S(p) = \frac{1}{10}$ *for* $p \in [0, 10]$ and $\phi^S(p) = 0$ *for* $p \in [10, 100]$. Although the distributions on the productivity of employees are quite simple, these distributions satisfy the first-order stochastic dominance.[3] In the base line situation, the search equilibrium exists uniquely.

1. Wage and market tightness

Figure 4 shows that the wage initially increases and then decreases with respect to SP s given a constant level of PI z. This implies that the increase in SP damages the employee's incentives when SP is small. Thus, SP has a negative effect on the incentives of an employee, since SP is an earning for a shirking employee. Hence, as SP

3 The part $\Phi^S(\hat{p}) - \Phi(\hat{p})$ of the (IC) condition is crucial to the incentives of workers. As the first order stochastic dominance of the distribution functions is satisfied, this part increases first, and then decreases with respect to $\hat{p}$. This feature holds under typical distribution functions similar to normal distributions. Clearly, this feature holds under the base line.

increases, it pushes the wage and the threshold of dismissal upwards such that the incentives of an employee are maintained. Figure 5 shows the relationship between market tightness and EPL. An increase in SP decreases the market tightness. This implies that the present-discounted payoff J of a matched firm decreases as a result of the increase in SP, and hence, job vacancies exit the labor market. High SP increases the cost of a match for a firm, and thus, it induces firms to exit the market. A decline in the market tightness is a credible threat to shirking behavior because fired workers have difficulty in obtaining reemployment.

When SP is large, market tightness is very small. This results in a high cost of shirking behavior for employees. Therefore, the wage decreases after SP exceeds a particular level.

On the other hand, the influence of PI on the wage is not significant when SP is small. When SP is in the middle range and PI is not severe—for example, $s = 20$ and $z = 4$—the increase in PI positively affects the incentives of employees. Since PI deters a firm from firing employees frequently, a diligent employee benefits more from the resultant high job security than a shirking employee. This is the positive commitment effect.

An increase in PI results in a decrease in market tightness when SP is either very small or large. However, when SP is in the middle range, for example, around $s = 20$, PI increases the market tightness; in this case, the benefits of job security are more than the cost. Higher job security decreases the wage and increases the matching profit. In fact, around $s = 20$, the market tightness in the case of $z = 8$ is more than that in the cases of $z = 0$ and $z = 4$. However, if PI is excessively severe, for example, the case of $z = 12$, it reduces the market tightness. Thus, very stringent PI damages the profits of a firm.

2. Threshold of dismissal and unemployment rate

Figure 6 shows the effect of EPL on the threshold $\hat{p}$ of dismissal. Figure 6 is similar to Figure 4. As SP increases, initially, an employee is more likely to be fired. It appears that a high SP deters firms from firing employees. However, as SP increases, a high wage is offered to maintain employees' incentives. This induces employees to be likely fired. Then, as SP increases further, they are unlikely to be fired. In the latter situation, the wage and market tightness decrease as SP increases. If an employee is fired in this situation, he or she will find it difficult to obtain reemployment elsewhere. This is the driving force behind the incentives of workers. Fewer dismissals and long-term unemployment are observed in this situation.

An increase in PI does not significantly affect the threshold of dismissal when SP is small but reduces the threshold as SP increases.

The relationship between unemployment rate and EPL is represented in Figure 7. The unemployment rate is given by (7) and depends on the market tightness and the threshold of dismissal. Since the increase in SP decreases market tightness, the unemployment rate increases when SP increases the threshold of dismissal. As Figure 7 shows, this occurs when SP is small. On the other hand, when SP is in the middle range, the threshold of dismissal reduces as SP increases. If this effect dominates the reducing effect of market tightness, the unemployment rate reduces with respect to SP. In fact, around $s = 25$ and $z = 0$ or $z = 4$, the increase in SP pulls down the unemployment rate.

When SP is in the middle range, as PI increases, market tightness improves and the threshold of dismissal reduces. This results in a reduction in the unemployment rate. The effect of PI on reduction in the unemployment rate appears only when PI is in the appropriate range. If PI is severe, for example $z = 12$, the effect disappears, that is, an increase in PI results in an increase in the unemployment rate. When SP is small or large, the influence of PI on the unemployment rate is not significant.

3. Welfare

As the same situation is repeated in every period on the equilibrium path, it is sufficient to consider the welfare level in one period. Welfare in one period is given by:

$$\Omega \equiv \left\{ \int_{\hat{p}}^{\bar{p}} p\phi(p)dp + \Phi(\hat{p})(\bar{w} - z) - c \right\}(1-u) + u\bar{w} - k\theta u .$$

Figure 8 shows the level of welfare. When SP is in the middle range, an appropriate PI improves welfare through the positive commitment effect.

Welfare improves gradually with respect to SP when SP is small. This positive effect on welfare may be due to the elimination of the negative search externality. Welfare improves if EPL solves the search externality.

In some previous studies, the externality is excluded and the focus is on the net effect of EPL. If the studies based the termination of a match and the determination of wages on the Nash bargaining solution, similar to the textbook model, it is technically easy for them to bypass the effect of the search externality because only the Hosios (1990) condition need be satisfied. However, in our model, a match is not always dissolved efficiently by wage rigidity, and PI is socially wasteful. Therefore, it is difficult to completely eliminate the effect of the search externality.

Fortunately, we can estimate the effect of the search externality on the basis of previous studies. When the bargaining power of an employee is weak compared to the elasticity of the matching function, the unemployment rate is very small from the viewpoint of efficiency. In this case, welfare improves if a policy or an institutional device increases the unemployment rate. In our model, the level of SP is relevant to the bargaining power of an employee since high SP increases the *ex post* rent E-U of an employee. High SP is similar to the case in the textbook model wherein an employee has strong bargaining power. This implies that welfare increases with respect to SP when SP is small. In fact, as Figure 8 shows, welfare improves as SP increases. In our model, the termination of a match is not always efficient, which distinguishes our model from the textbook model with Nash bargaining. Although different factors can influence welfare even when SP is small, the elimination of the negative search externality also affects welfare.

In the textbook model, the efficient level of bargaining power is uniquely determined by the Hosios condition. When the bargaining power of an employee begins from a very small level, as the bargaining power increases, welfare improves initially and then declines. If the search externality is only crucial to welfare, the curve of welfare should be shaped like a mound with respect to SP. In contrast, in our model, the curve of welfare is not shaped like a mound, but rather is comparatively complex. Thus, this study shows that PI improves welfare in the middle range of SP and that this effect is different from the effect of eliminating the search externality.

4. Discount rate

The discount rate in this numerical illustration is 0.0125, which means that quarterly periods are used in the model. When the productivity of an employee is low, he/she is unlikely to be fired if such a situation continues only for a quarter. Taking the vacancy cost into account, a firm is willing to retain the employee if the low productivity is expected for a short period only. In contrast, if the low productivity persists for a long time, the firm would be unwilling to retain the match and thus it is likely to be dissolved.

To check the long-term low productivity situation, we implement a numerical illustration with large discount rates. For example, consider the case of $r = 0.1$, which indicates that the low productivity situation continues for approximately 2 years. A high discount rate increases the threshold of dismissal as well as the unemployment rate. This result is natural. However, under the middle range of SP, a more stringent PI, $z = 8$, pulls down the unemployment rate in the case of $r = 0.1$ to a greater extent than in the case of $r = 0.0125$. The difference in the unemployment rate between $z = 8$ and $z = 4$ is denoted as $\Delta u \equiv u_{z=8} - u_{z=4}$ in Figure 9a. To reduce the unemployment rate, PI is more effective in the case of $r = 0.1$ than in the case of $r = 0.0125$. Similarly, the difference in welfare $\Delta\Omega \equiv \Omega_{z=8} - \Omega_{z=4}$ is represented in Figure 9b. The welfare-improving effect is larger in the case of $r = 0.1$ than in the case of $r = 0.0125$. Thus, the positive effect of PI is not necessarily smaller when low productivity persists for a long time.

5. Conclusion and Discussion

We use the efficiency wage model with matching technology to analyze effects of EPL on the incentives of workers. Wage rigidity is crucial to our result. If wage is sufficiently flexible, the employment relationship is efficiently terminated, thereby decreasing the likelihood of EPL playing a significant role as a commitment device for job security. When wage is *ex post* inflexible, a higher number of employees are fired because the decision to dismiss is based on the original wage that is higher than the productivity in the outside labor market. Hence, as we have shown, there is scope for improving social welfare by implementing EPL.

EPL generates two effects: the *disincentive effect* and the *commitment effect*. If the latter dominates the former, EPL improves welfare. Moreover, we have been concerned about the differences between SP and PI. It seems that SP is better than PI from the perspective of social welfare. However, SP is an earning for shirking employees, and thus, it may negatively affect the incentives of employees as compared with PI.

Similar to the results of previous studies regarding EPL, our results on the effects of EPL are ambiguous. Hence, we implemented the following numerical illustrations: [1] when SP is small or large, the disincentive effect dominates the commitment effect. In contrast, SP does not negatively affect the incentives of an employee when SP is in the middle range. [2] PI does not influence the economy when SP is small or large; however, it decreases the threshold of dismissal and the unemployment rate and thus improves social welfare when SP is in the middle range. [3] Very stringent PI negatively affects the incentives of an employee. When EPL is very stringent, it fatally damages the incentives of employees. Therefore, it is necessary to design EPL appropriately.

As summarized in an OECD (2007) report, there has been controversy over the effects of EPL, both theoretically and empirically. We do not introduce the entire literature here, but rather briefly mention some salient points highlighted in previous studies. Bertola, Boeri, and Cases (2000) and Belot and Ours (2004) indicate that in the real world, the ambiguity is caused by the complex institutions that influence the market. Bertola and Rogerson (1997) point out that one of the reasons for ambiguity is the influence of wage-setting institutions. For example, in European countries, unions play a significant role in central wage bargaining; therefore, the wage differences across firms are likely to be small in these countries. Hence, firms are willing to adjust employee numbers owing to the inflexibility of wage adjustment. On the other hand, stringent EPL deters job matching separation. These opposite inputs affecting job turnover lead to ambiguity on the level of employment. In fact, according to Blanchard and Portugal (2001)—who investigated the empirical data of the U.S. and Portugal in detail—the annual rates of job creation and destruction in the U.S. and Portugal are similar, and the significant differences in their quarterly rates are hidden by the similarity in the annual rates. Garibaldi and Violante (2005) use OECD country data and find that an increase in the stringency of EPL reduces unemployment rate but that an increase in the stringency of EPL accompanied by central determination of wage increases the unemployment rate.

These studies show that the method of wage adjustment is relevant to the effects of EPL. We have shown that under wage rigidity, EPL, and particularly PI, has positive effects in terms of workers' incentives.

In this paper, we have focused on the effects of EPL, but do not consider unemployment insurance (UI); however, we recognize that it is crucial to compare EPL with UI. In fact, there are seminal studies on the comparison between EPL and UI. Ljungqvist and Sargent (1998) (2007) and Rogerson and Schindler (2002) point out that UI prevents the unemployed from obtaining a new job and thus leads to long-term unemployment.[4] Pissarides (2001) shows that there is no scope to improve welfare by implementing EPL if UI is perfect; however, EPL has positive effects on welfare if UI is not perfect. Blanchard and Tirole (2008) indicate that an appropriate combination between dismissal tax as EPL and UI is necessary under the imperfectness of UI, liquidity constraints, or wage bargaining. Mortensen and Pissarides (1999) focus on different effects between skilled and unskilled workers. They show that UI more negatively affects the job-search incentives of unskilled workers than the skilled workers, and that EPL increases job security more for the skilled than for the unskilled.

[4] In contrast, Acemoglu and Shimer (1999) mention that UI enables the unemployed to carefully search for a new job that corresponds exactly to their characteristics.

Thus, while we believe that UI is an important topic when considering employment problems, we have not included it in the scope of our paper. This is because, in our paper, a risk problem is not crucial since we assume the players to be risk neutral. EPL positively affects the incentives of an employee if it is appropriately designed. The result is irrelevant to the design of UI if the reservation wage includes UI.

Appendix

Proof of proposition 1

The minimum wage that satisfies (4) is denoted as w^*. Since the IC condition in (4) is binding at the equilibrium, it holds at the equilibrium that $IC_w \equiv \frac{\partial IC(w^*)}{\partial w^*} > 0$. The proof is as follows. Suppose that $IC_w \leq 0$. In this situation, the firm can reduce the wage further as long as the IC condition in (4) is satisfied, and thus, increase the firm's profit. This contradicts the notion that the original wage maximizes the firm's profit. Hence, it holds that $IC_w > 0$ at the equilibrium.

Next, we conduct comparative statics on the search equilibrium with respect to s subject to $df = ds + dz = 0$ as follows:

$$\begin{pmatrix} dw^*/ds \\ d\theta/ds \end{pmatrix} = \frac{-1}{IC_w \frac{kq'}{q^2} - IC_\theta \tilde{J}_w} \begin{pmatrix} \frac{kq'}{q^2} & -IC_\theta \\ -\tilde{J}_w & IC_w \end{pmatrix} \begin{pmatrix} IC_s \\ \tilde{J}_s \end{pmatrix},$$

where $IC_s \equiv \frac{\partial IC(w^*)}{\partial s} = -\frac{r + \theta q(\theta)}{r + \theta q(\theta) + \Phi^S(\hat{p})}\{\Phi^S(\hat{p}) - \Phi(\hat{p})\} < 0$ and $\tilde{J}_s \equiv \frac{\partial \tilde{J}}{\partial s} = 0$.

Using the locally stable condition (8) and $\tilde{J}_w = -\frac{1 - \Phi(\hat{p})}{r + \Phi(\hat{p})} < 0$, it holds that

$$\begin{pmatrix} dw^*/ds \\ d\theta/ds \end{pmatrix} = \frac{-1}{IC_w \frac{kq'}{q^2} - IC_\theta \tilde{J}_w} \begin{pmatrix} \frac{kq'}{q^2} IC_s \\ -\tilde{J}_w IC_s \end{pmatrix}.$$

Hence, $\left.\frac{dw^*}{ds}\right|_{f=\bar{f}} > 0$ and $\left.\frac{d\theta}{ds}\right|_{f=\bar{f}} < 0$. The results lead to $\left.\frac{d\hat{p}}{ds}\right|_{f=\bar{f}} > 0$ from (6), and thus, it holds from (7) that $\left.\frac{du}{ds}\right|_{f=\bar{f}} > 0$. ■

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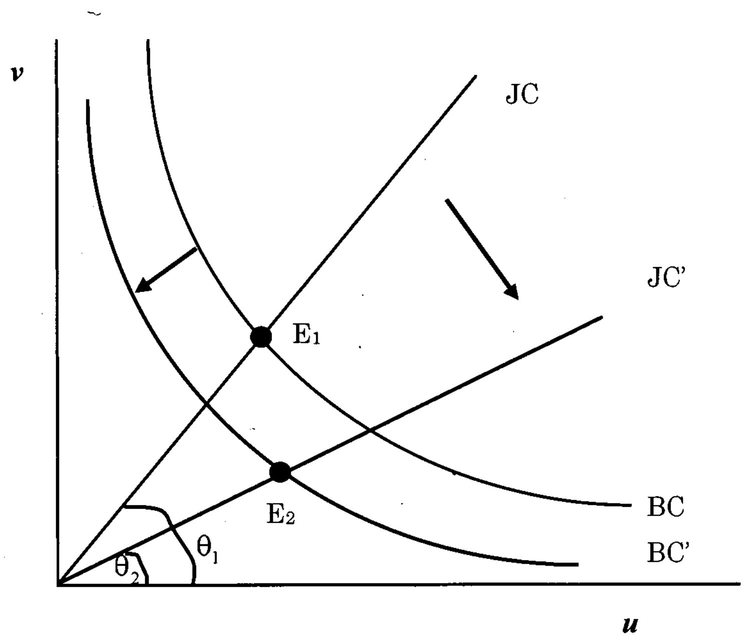

Figure 1

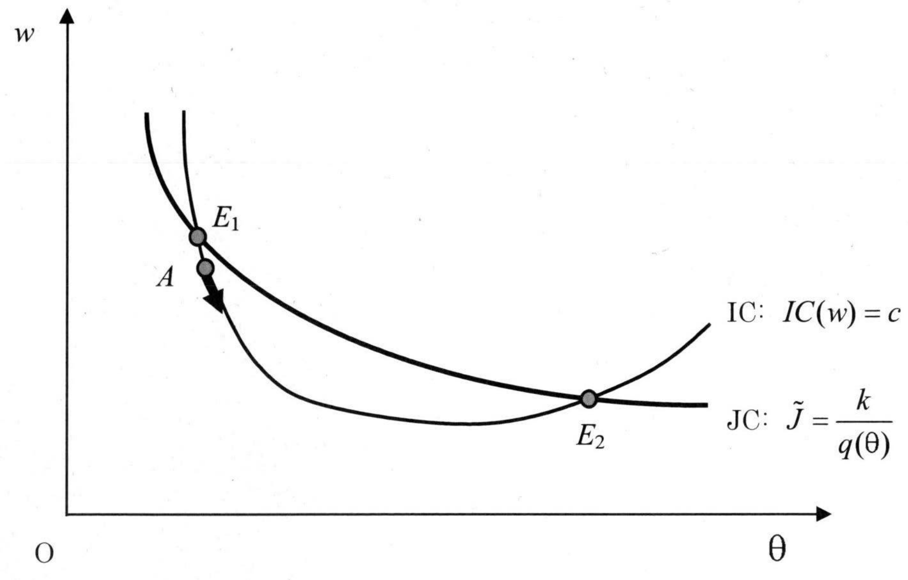

Figure 2