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Abstract

Workers temporarily leave their jobs for various reasons, for example, maternity, caregiving, and illness. In such a situation, a firm can lay off these workers and search for a new worker. To protect workers from such a firm's behavior, many developed countries have implemented a mandatory leave policy. The goal of this study was to rationalize such a government intervention in the labor market from an efficiency perspective. To achieve this objective, this study constructed a search-theoretic model of the labor market and analyzed a steady-state equilibrium in the model. The results demonstrated that introducing a mandatory leave policy increases efficiency under certain conditions. This result justifies such government interventions in the labor market from an efficiency perspective.

Keywords: Search-theoretic model of the labor market, temporary leave, mandatory leave policy, efficiency

JEL Classification: E24, E60, J20

1 Introduction

Workers require temporary leave for various reasons, for example, maternity, caregiving, and illness. To protect such workers from losing their jobs, governments in most developed countries ensure that employees have the right to return to their jobs after the paid or unpaid leave period. Thus, this study aimed to answer the following research question: Does government intervention in ensuring workers' rights to paid and unpaid leave result in economic benefits?

The model in this study is based on those in Pissarides (1985a) and Mortensen and Pissarides (1994), although labor productivity is constant for tractability. What this study contributes to the literature is the context that workers temporarily leaving firms for various reasons is inevitable. Different from the job destruction described in Pissarides (1985a) and Mortensen and Pissarides (1994), the job can be maintained if the firm pays some costs. The firm, of course, can also make the position redundant and/or terminate the employee and then search for a new worker in the labor market. If the firm maintains the

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position and the employee, the worker on temporary leave returns at the end of the stipulated period. This study examines a steady-state equilibrium in such a model.

In this model, the firm prefers to fire its employees who request temporary leave and search for a new worker in the labor market if the expected cost of maintaining the job is greater than the expected cost of opening a vacancy in a steady-state equilibrium.[1] If the firm's preference is implemented, the result would be many unemployed workers who would prefer to retain their jobs, and labor market tightness, defined by the ratio of the number of vacancies to the number of unemployed workers, would be too *loose*. In such a case, if the government had implemented a mandatory leave policy, the firm would have to retain the position for the worker when she returns. Thus, this policy would decrease unemployment and increase employment, increasing output in a steady-state equilibrium. Although the cost of maintaining the job is incurred by the firm owing to the introduction of a mandatory leave policy, output increases, implying that efficiency may increase by introducing a mandatory leave policy.[2] Next, this study determines when a mandatory leave policy increases efficiency.

The main conclusion is that when the rate at which employees leave their jobs temporarily is sufficiently low, an introduction of a mandatory leave policy increases efficiency even for firms unwilling to implement the policy under certain conditions. To provide a sufficient condition, this study considered the model *without* temporary leave shock.[3] Thus, the sufficient condition was that the cost of opening a vacancy in a steady-state equilibrium in the model without a temporary leave shock is larger than the cost of maintaining a job that the firm has to bear in a steady-state equilibrium, that is, the product of the bargaining power of a firm and the cost of maintaining a job. Hence, when the cost of opening a vacancy in a steady-state equilibrium in the model without a temporary leave shock is smaller than the cost of maintaining a job but is larger than the the product of the bargaining power of a firm and the cost of maintaining a job, the mandatory leave policy is justifiable from an economic efficiency perspective.

The intuition behind this result is that the labor market is too loose from an efficiency perspective due to the externality if firms lay off workers on leave and search for new workers and that a mandatory leave policy can solve this problem to increase the tightness of the labor market. Such an externality of the labor market has been discussed in Pissarides (1984) and Hosios (1990). Pissarides (1984) showed that equilibrium labor market tightness is generally different from the efficient level and argued that unemployment insurance might be necessary to improve efficiency.[4] Hosios (1990) showed the condition under which bargaining over wage achieves efficiency.

This study also referred to theoretical studies on parental leave policy such as Erosa et al. (2010), Del Rey et al. (2017), and Bastani et al. (2019). Erosa et al. (2010) constructed a general equilibrium model in which agents may leave because of maternity and conducted quantitative analysis to show the effect of mandatory parental leave policy on economic variables. Del Rey et al. (2017) considered a simpler model than that in Erosa et al. (2010) and investigated analytically how the extension of a leave period affects the equilibrium wage and labor market tightness. These two papers have considered how a change in leave policy affects equilibrium variables. By contrast, this study focused on how introducing a leave policy affects equilibrium variables. Bastani et al. (2019) constructed an asymmetric information

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[1]The length of the leave period is stochastic and follows a Poisson process.

[2]The definition of efficiency in this paper is measured by the discounted sum of economic surplus. See, for instance, chapter 8 in Pissarides (2000).

[3]Hence, the model without a temporary leave shock is the same as the model in chapter 1 in Pissarides (2000).

[4]Pissarides (1985b) also examined the effect of labor market policies on equilibrium variables in a simple labor search model.

model in which firms did not know their workers' degree of preference for using parental leave and showed that parental leave policy improves social welfare. To the best of my knowledge, this paper is the first to rationalize parental leave policy from an economic perspective. The findings of this study justify the parental leave policy in a dynamic setting, and the model in Bastani et al. (2019) is static.

The remainder of the paper is organized as follows: Section 2 describes the economic model, Section 3 characterizes a steady-state equilibrium, Section 4 shows when mandatory leave policy can improve efficiency, and Section 5 concludes.

2   Model

Time runs continuously, and the horizon is infinite.

There are workers and firms in the economy. There is a unit measure of workers who are homogeneous, risk neutral, and infinitely lived. They maximize the expected discounted lifetime utility, and their discount rate is $r > 0$. There are three states for a worker: employed, unemployed, and on leave. An employed worker works at the firm, receives endogenously determined wage w, and derives flow utility w. An employed worker becomes unemployed at rate $\lambda > 0$, which is exogenously given. The literature, such as Pissarides (1985b), has considered this shock to be "the outcome of firm specific (structural) shifts in demand." An unemployed worker's flow utility is b, and she searches for a job. An employed worker is on leave at rate $\sigma > 0$, which is also exogenously given. This shock is regarded as the outcome of a worker-specific event such as illness, maternity, or caregiving. The flow utility of a worker on leave is z. A worker on leave cannot work for a certain period. A worker on leave will return to work or search for a job at rate $\gamma \in (0,1]$, which is exogenously given. For simplicity, I assume that a worker's productivity does not change despite the worker being on temporary leave.[5]

Analogous to the literature, a free entry condition determines the measure of firms. The production technology is constant returns to scale, with labor as the only input. Each employed worker produces y units of output. Each firm hires one worker. The firm is risk neutral and infinitely lived. A firm entering the market incurs a vacancy cost, $k > 0$, per unit of time when it searches for a worker. If a firm hires a worker, production occurs, and the firm's profit is $\pi := y - w$. If an employed worker is on temporary leave at rate σ, the firm can maintain the job with cost $c > 0$ per unit of time. If the firm maintains the job, production resumes after the worker returns. Another choice is available to the firm: lay off the current worker experiencing a temporary leave shock and search for a new worker in the labor market. The firm maximizes expected discounted profits, and it discounts future profits at r. There are also three states for the firm: filled and producing, vacant and searching, and waiting for the worker on leave to return.

The measure of job matches occurring per unit of time is given by $m = m(u,v)$, where u is the measure of unemployed workers, and v is the measure of vacancies. The matching function, $m(u,v)$, is increasing in both arguments, concave, and homogeneous of degree one. Let $\theta := \frac{v}{u}$ be the *tightness* of the labor market. Then, the rate at which vacancies are filled is $q(\theta) := \frac{m(u,v)}{v} = m\left(\frac{1}{\theta}, 1\right)$. Notably, $q'(\theta) < 0$ is satisfied. The rate at which unemployed workers can find jobs is $\theta q(\theta) = \frac{m(u,v)}{u}$, and $\frac{\partial [\theta q(\theta)]}{\partial \theta} = q(\theta)(1 - \eta(\theta)) > 0$, where $\eta(\theta) := -\theta \frac{q'(\theta)}{q(\theta)} \in (-1,0)$ is the elasticity of $q(\theta)$.

Next, this study focuses on a steady state. Let V, $J(\pi)$, and $X(\pi)$ denote the present value of creating a

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[5] For instance, the same assumption is imposed implicitly in Del Rey et al. (2017) and Del Rey et al. (2021).

vacancy, that of filling a job whose profit is π, and that of maintaining a job whose profit is π, respectively. The Bellman equations are

$$
\begin{aligned}
rV &= -k + q(\theta)[J(\pi) - V], & (1) \\
rJ(\pi) &= \pi + \lambda[V - J(\pi)] + \sigma[\max\{V, X(\pi)\} - J(\pi)], & (2)
\end{aligned}
$$

and

$$
rX(\pi) = -c + \gamma[J(\pi) - X(\pi)]. \tag{3}
$$

Notably, the productivity of a worker on leave does not change even after the worker returns. Hence, even if a firm and a worker who returned to the job bargain over the wage, from the Nash bargaining solution, the same wage as the worker received before leave will be paid to the worker in equilibrium. Thus, the same π is observed in both sides of Equations (2) and (3). Equation (2) expresses that if a worker leaves the job temporarily, a firm will lay off the current worker and search for a new worker or wait for the worker to return, depending on which value is highest.

Let U and $W(w)$ denote the present value of being unemployed and that of being employed at wage w. Then, the Bellman equation for an unemployed worker is

$$
rU = b + \theta q(\theta)[W(w) - U]. \tag{4}
$$

Let L be the present value of a worker on leave who will not return to their job after the leave period. Then, if a firm does not maintain the job for a worker on leave, the Bellman equation for a worker is

$$
rW(w) = w + \lambda[U - W(w)] + \sigma[L - W(w)], \tag{5}
$$

and that for a worker on leave is

$$
rL = z + \gamma(U - L). \tag{6}
$$

Let $L(w)$ denote the present value of a worker on leave whose job is maintained by a firm. Then, the Bellman equation for a worker in this case is

$$
rW(w) = w + \lambda[U - W(w)] + \sigma[L(w) - W(w)], \tag{7}
$$

and that for a worker on leave in this case is

$$
rL(w) = z + \gamma[W(w) - L(w)]. \tag{8}
$$

Using these notations, the wage is a solution to the generalized Nash bargaining problem. Therefore, w satisfies

$$
w \in \arg\max_w [W(w) - U]^\beta [J(\pi) - V]^{1-\beta}, \tag{9}
$$

where β is the bargaining power of a worker, and $1 - \beta$ is that of a firm.

Last, this study discusses how the measure of each type of worker evolves. This also depends on a firm's choice. If a firm lays off a worker and searches for a new worker, the evolution of unemployed workers is given by

$$
\dot{u} = \gamma l + \lambda e - \theta q(\theta) u.
$$

Moreover, the evolution of employed workers and workers on leave is given by

$$\dot{e} = \theta q(\theta)u - (\lambda + \sigma)e, \ \dot{l} = \sigma e - \gamma l,$$

where e and l are the measure of employed workers and workers on leave, respectively. Notably, $u + e + l = 1$ is satisfied. In a steady state,

$$u = \frac{(\lambda + \sigma)\gamma}{\gamma(\lambda + \sigma) + (\gamma + \sigma)\theta q(\theta)}, \tag{10}$$

$$e = \frac{\gamma\theta q(\theta)}{\gamma(\lambda + \sigma) + (\gamma + \sigma)\theta q(\theta)}, \tag{11}$$

$$l = \frac{\sigma\theta q(\theta)}{\gamma(\lambda + \sigma) + (\gamma + \sigma)\theta q(\theta)}. \tag{12}$$

If a firm maintains the job, the evolution of unemployed workers is given by

$$\dot{u} = \lambda e - \theta q(\theta)u.$$

Similarly, the evolution of employed workers and workers on leave is given by

$$\dot{e} = \theta q(\theta)u + \gamma l - (\lambda + \sigma)e, \ \dot{l} = \sigma e - \gamma l.$$

Then, in a steady state,

$$u = \frac{\lambda\gamma}{\lambda\gamma + (\gamma + \sigma)\theta q(\theta)}, \tag{13}$$

$$e = \frac{\gamma\theta q(\theta)}{\lambda\gamma + (\gamma + \sigma)\theta q(\theta)}, \tag{14}$$

and

$$l = \frac{\sigma\theta q(\theta)}{\lambda\gamma + (\gamma + \sigma)\theta q(\theta)}. \tag{15}$$

The formal definition of an equilibrium concept is as follows:

Definition 2.1. *An* **(steady-state) equilibrium** *consists of* $((V, J, X), (U, W, L), w, (u, e, l, \theta))$ *such that*

1. (V, J, X) *satisfies Equations (1), (2), and (3);*

2. (U, W, L) *satisfies Equations (4), (5), and (6) if* $V > X(y - w)$; *otherwise,* (U, W, L) *satisfies Equations (4), (7), and (8);*

3. *Given* (W, U, J, V), *w satisfies Equation (9);*

4. *A free entry condition holds, that is,* $V = 0$;

5. (u, e, l, θ) *satisfies Equations (10), (11) and (12) if* $V > X(y - w)$; *otherwise,* (u, e, l, θ) *satisfies Equations (13), (14) and (15).*

3 Characterizing an equilibrium

3.1 An equilibrium in which a firm maintains the job for a worker on leave

In this equilibrium, a firm maintains the job by paying the costs, and a worker on leave returns to the job after the leave period.

From Equation (2) and a free entry condition,

$$\left(r + \lambda + \frac{r\sigma}{r+\gamma}\right) J(\pi) = \pi - \frac{\sigma}{r+\gamma} c. \tag{16}$$

A free entry condition and Equation (1) lead to

$$J(\pi) = \frac{k}{q(\theta)}. \tag{17}$$

Hence, Equation (16) and (17) imply the following *job creation* condition:

$$y - w - \frac{\sigma}{r+\gamma} c = \left(r + \lambda + \frac{r\sigma}{r+\gamma}\right) \frac{k}{q(\theta)}. \tag{18}$$

In equilibrium, the surplus from the match for the firm should be equal to the present value of the expected cost of job vacancies The firm's net surplus from the match includes the cost of maintaining the job, $\frac{\sigma}{r+\gamma} c$, because the firm maintains the job until a worker on leave finishes the leave period and returns to the firm. The right side of Equation (18) expresses the present value of the expected cost of opening vacancies. Because a worker takes a temporary leave with probability σ and returns to the job with probability γ, $\frac{r\sigma}{r+\gamma}$ appears here.

From the first-order condition of the Nash bargaining problem and $W'(w) = J'(\pi) = \frac{r+\gamma}{(r+\gamma)(r+\lambda)+\sigma r}$, I have

$$W(w) - U = \beta \left[W(w) - U + J(\pi) - V\right]. \tag{19}$$

From Equations (7) and (8),

$$\left(r + \lambda + \frac{r\sigma}{r+\gamma}\right) \left[W(w) - U\right] = w + \frac{\sigma}{r+\gamma} z - \frac{r+\gamma+\sigma}{r+\gamma} rU \tag{20}$$

holds. Applying Equations (20) and (16) to Equation (19), equilibrium wage is given by

$$w = rU + \frac{\sigma}{r+\gamma}(rU - z) + \beta \left[y - rU - \frac{\sigma}{r+\gamma}(rU - z) - \frac{\sigma}{r+\gamma} c\right]. \tag{21}$$

The reservation wage is $w_R = rU + \frac{\sigma}{r+\gamma}(rU - z)$.[6] Hence, the equilibrium wage is the sum of the reservation wage and β ratio of the firm's net surplus of production.

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[6]The *reservation wage* is the wage that satisfies $W(w_R) = U$. In this model, $w_R = rU + \frac{\sigma}{r+\gamma}(rU - z)$, and this equation can be derived from Equation (20).

Replacing rU in Equation (21) by $rU = b + \frac{\beta}{1-\beta}\theta k$, I have the following wage equation:

$$w = \beta\left[y + \theta k + \frac{\sigma}{r+\gamma}(\theta k - c)\right] + (1-\beta)\left[b + \frac{\sigma}{r+\gamma}(b-z)\right]. \tag{22}$$

Let θ^1 and w^1 be a solution that satisfies Equations (18) and (22) together. For $\theta^1 > 0$ and $w^1 > 0$, the following assumption is imposed.

Assumption 3.1. *Parameters satisfy*

$$0 \le b + \frac{\sigma}{r+\gamma}(b-z) < y - \frac{\sigma}{r+\gamma}c.$$

Proposition 3.1. *Suppose Assumption 3.1 holds. Then, there is a solution (θ^1, w^1), where $\theta^1 > 0$ and $w^1 > 0$, that solves Equations (18) and (22).*

Proof. See the Appendix. □

In this equilibrium, $X(y - w^1) \ge V$ must hold. What conditions on parameter values must be satisfied? In the following, I provide a sufficient condition under which $X(y - w^1) > V$ holds in equilibrium. This sufficient condition uses equilibrium labor market tightness in an economy with $\sigma = 0$. In such an economy, a job creation condition in equilibrium is characterized by[7]

$$y - w = (r + \lambda)\frac{k}{q(\theta)}, \tag{23}$$

and the equilibrium wage equation is given by

$$w = \beta y + (1-\beta)\left(b + \frac{\beta}{1-\beta}\theta k\right).$$

Assuming $y > b$, there is a stationary equilibrium. Let $\theta^\star$ be a unique solution to Equation (23). Hereafter, $y > b$ is assumed to be satisfied.

Lemma 3.1. *Suppose*

$$\frac{k}{q(\theta^\star)} > \frac{c}{\gamma} \tag{24}$$

holds. Then, for sufficiently small $\sigma > 0$, $X(y - w^1) > V$. If

$$\frac{c}{\gamma} > \frac{k}{q(\theta^\star)} \tag{25}$$

holds, then, for sufficiently small $\sigma > 0$, $V > X(y - w^1)$.

Proof. See the Appendix. □

This lemma implies the following result.

Proposition 3.2. *Suppose Assumption 3.1 holds. Suppose, further, that Equation (24) holds. Then, there is an equilibrium, where $\theta^1 > 0$ and $w^1 > 0$, and it is characterized by Equations (18), (22), (13), (14), and (15).*

Hereafter, θ^1, w^1, e^1, u^1, and l^1 are equilibrium variables in this case.

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[7]For the derivation, see, for instance, Chapter 1 in Pissarides (2000) and Section 4 in Rogerson et al. (2005).

3.2 An equilibrium in which a firm does not maintain the job for a worker on leave

In this subsection, an equilibrium is characterized by which a firm does not wait for a worker on leave to return to the job after the leave period. Hence, $V > X(\pi)$ must hold in this equilibrium.

From Equations (4), (5), and (6),

$$(r+\lambda+\sigma)[W(w)-U] = w + \frac{\sigma}{r+\gamma}z - r\frac{r+\gamma+\sigma}{r+\gamma}U \tag{26}$$

holds. From Equation (2) and a free entry condition,

$$(r+\lambda+\sigma)J(\pi) = y - w \tag{27}$$

holds. Moreover, a free entry condition and Equation (1) imply that

$$J(\pi) = \frac{k}{q(\theta)}. \tag{28}$$

Then, from Equations (27) and (28), the job creation condition in this case is given by

$$y - w = (r+\lambda+\sigma)\frac{k}{q(\theta)}. \tag{29}$$

Plugging Equation (26) into Equation (19) and rearranging the equation leads to

$$w = rU + \sigma\frac{rU-z}{r+\gamma} + \beta\left(y - rU - \sigma\frac{rU-z}{r+\gamma}\right). \tag{30}$$

From Equation (19), $W(w) - U = \frac{\beta}{1-\beta}J(\pi) = \frac{\beta}{1-\beta}\frac{k}{q(\theta)}$. Then, Equation (4) is written as

$$rU = b + \frac{\theta\beta k}{1-\beta}. \tag{31}$$

Substituting rU in Equation (30) by Equation (31), the wage equation is given by

$$w = \beta\left(y + \theta k + \frac{\sigma}{r+\gamma}\theta k\right) + (1-\beta)\left[b + \frac{\sigma}{r+\gamma}(b-z)\right]. \tag{32}$$

Hereafter, let θ^0, w^0, e^0, u^0, and l^0 be equilibrium variables for this case.

Proposition 3.3. *Suppose Assumption 3.1 holds. Suppose, further, that Equation (25) holds. Then, there is an equilibrium, where $\theta^0 > 0$ and $w^0 > 0$, and it is characterized by Equations (29), (32), (10), (11), and (12).*

Proof. See the Appendix. □

4 Increasing efficiency by introducing a mandatory leave policy

In this section, I focus on the case where Equation (25) holds. That is, a firm wants to fire a worker who experiences a temporary leave shock and then search for a new worker in the labor market rather than wait for the worker to return to the job after the leave period. The main result of this section is that by forcing firms to maintain workers' jobs while they are on leave, efficiency increases. Before showing the main result, first, I compare θ^1 with θ^0 in the following proposition:

Proposition 4.1. *Suppose Assumption 3.1 holds. For sufficiently small $\sigma > 0$, $\theta^1 > \theta^0$ if and only if*

$$\frac{k}{q(\theta^\star)} > (1-\beta)\frac{c}{\gamma}. \tag{33}$$

Additionally, if $(1-\beta)\frac{c}{\gamma} < \frac{k}{q(\theta^\star)} < \frac{c}{\gamma}$, $w^0 > w^1$ for sufficiently small σ.

Proof. See the Appendix. □

The left side of Equation (33) is the expected cost of opening a vacancy when σ is sufficiently small, and the right side is the expected cost to the firm of maintaining the job. Equilibrium labor market tightness is determined by the job creation equation and the wage equation. The job creation equation when the mandatory leave policy is introduced is Equation (18), which can be written as

$$y - w = (r+\lambda+\sigma)\frac{k}{q(\theta)} - \frac{\gamma\sigma}{r+\gamma}\left(\frac{k}{q(\theta)} - \frac{c}{\gamma}\right).$$

Comparing this equation with the job creation equation when there is no leave policy, which is Equation (29), the job creation condition will move by $\frac{\gamma\sigma}{r+\gamma}\left(\frac{k}{q(\theta)} - \frac{c}{\gamma}\right)$ if the mandatory leave policy is introduced. When σ is sufficiently small, because $\theta^1 \to \theta^\star$ and $\theta^0 \to \theta^\star$, the size of the gap between two job creation equations is approximately $\frac{\gamma\sigma}{r+\gamma}\left(\frac{k}{q(\theta^\star)} - \frac{c}{\gamma}\right)$.

Analogously, if the wage equation with mandatory leave policy, which is Equation (32), is compared with that without mandatory leave policy, which is Equation (22), an introduction of the mandatory leave policy pushes the wage equation *downward* by $\frac{\beta\sigma}{r+\gamma}c$.

If $\frac{\gamma\sigma}{r+\gamma}\left(\frac{k}{q(\theta^\star)} - \frac{c}{\gamma}\right) > 0$, because the job creation equation moves *upward*, as Figure 1 shows, $\theta^1 > \theta^0$ holds. If $\frac{\gamma\sigma}{r+\gamma}\left(\frac{k}{q(\theta^\star)} - \frac{c}{\gamma}\right) < 0$, as long as the job creation equation changes *less* than the wage equation, that is,

$$-\frac{\gamma\sigma}{r+\gamma}\left(\frac{k}{q(\theta^\star)} - \frac{c}{\gamma}\right) < \frac{\beta\sigma}{r+\gamma}c \Leftrightarrow (1-\beta)\frac{c}{\gamma} < \frac{k}{q(\theta^\star)}$$

holds, as Figure 2 shows, $\theta^1 > \theta^0$ still holds in equilibrium.

Lemma 4.1. $\theta^1 > \theta^0$ *implies* $u^0 > u^1$, $e^0 < e^1$, *and* $l^0 < l^1$.
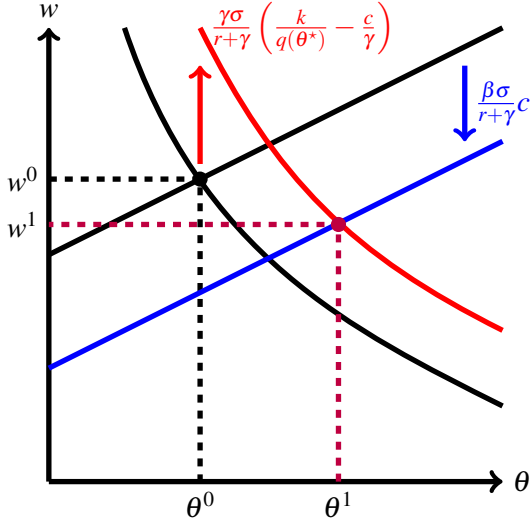
Proof. See the Appendix. □

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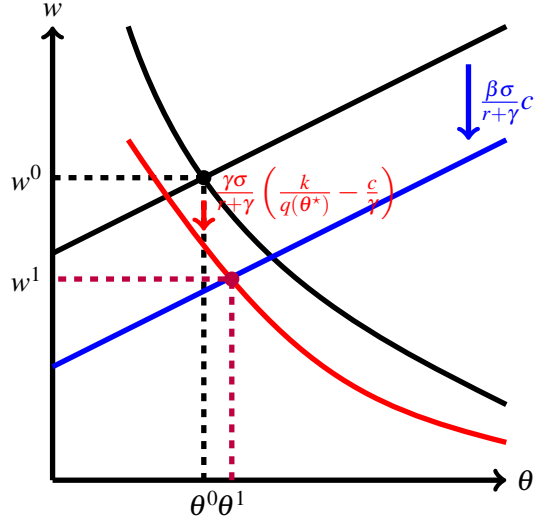Figure 1: When $\frac{k}{q(\theta^\star)} > \frac{c}{\gamma}$

Figure 2: When $(1-\beta)\frac{c}{\gamma} < \frac{k}{q(\theta^\star)} < \frac{c}{\gamma}$

Because workers on leave are *not* unemployed workers when the mandatory leave policy is introduced, $u^0 > u^1$ holds. Furthermore, after the leave period ends, workers on leave will return to work when the mandatory leave policy is introduced, whereas they search for a job when it is not introduced. This implies $e^0 < e^1$. Because only employees experience a temporary leave shock, $e^0 < e^1$ implies $l^0 < l^1$.

Referring to the literature such as Pissarides (2000), *efficiency* is measured by a discounted sum of all agent" utilities in a stationary equilibrium. Then, efficiency without a mandatory leave policy is measured by

$$W^0 := \int_0^\infty e^{-rt}[e^0 y + u^0 b + l^0 z - \theta^0 u^0 k]\mathrm{d}t$$

and that with the mandatory leave policy is measured by

$$W^1 := \int_0^\infty e^{-rt}[e^1 y + u^1 b + l^1 z - \theta^1 u^1 k - l^1 c]\mathrm{d}t.$$

Proposition 4.2. *Suppose Assumption 3.1, Equation (33), and*

$$\beta \geq \eta(\theta^\star) \tag{34}$$

hold. Then, $W^1 > W^0$ for a sufficiently small $\sigma > 0$. That is, efficiency increases owing to the government's intervention.

Proof. See the Appendix. □

Because efficiency is measured by a discounted sum of all agents' utilities in a steady-state equilibrium, $W^1 > W^0$ if and only if

$$S := (e^1 - e^0)y + [u^1(b - \theta^1 k) - u^0(b - \theta^0 k)] + (l^1 - l^0)z - l^1 c > 0.$$

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When Equation (33) holds, from Proposition 4.1 and Lemma 4.1, introducing a mandatory leave policy increases the output and benefits from being on leave. By contrast, it decreases net benefits from being unemployed and increases the cost of maintaining the job. A change in σ affects the measures of employed workers, workers on leave, and unemployed workers *directly* and *indirectly* through θ. Taking the derivative of S with respect to σ and evaluating it at $\sigma = 0$, I obtain

$$
\begin{aligned}
\left. \frac{\partial S}{\partial \sigma} \right|_{\sigma=0} &= \left[\frac{\theta^\star q(\theta^\star)}{[\lambda + \theta^\star q(\theta^\star)]^2} \left\{ y - (b - \theta^\star k) \right\} - \frac{\theta^\star q(\theta^\star)}{\lambda + \theta^\star q(\theta^\star)} \frac{c}{\gamma} \right] \\
&\quad + \left[\frac{\lambda [q(\theta^\star) + \theta^\star q'(\theta^\star)]}{[\lambda + \theta^\star q(\theta^\star)]^2} \left\{ y - (b - \theta^\star k) \right\} \left(\left. \frac{\partial \theta^1}{\partial \sigma} \right|_{\sigma=0} - \left. \frac{\partial \theta^0}{\partial \sigma} \right|_{\sigma=0} \right) \right. \\
&\quad \left. - \frac{\lambda k}{\lambda + \theta^\star q(\theta^\star)} \left(\left. \frac{\partial \theta^1}{\partial \sigma} \right|_{\sigma=0} - \left. \frac{\partial \theta^0}{\partial \sigma} \right|_{\sigma=0} \right) \right].
\end{aligned}
\tag{35}
$$

Equation (33) guarantees that the first bracket on the right side of Equation (35), which expresses the direct effect of a small change in σ on social welfare, is strictly positive. Equation (34), which expresses the indirect effect of a small change in σ on σ on social welfare, guarantees that the second bracket on the right side of Equation (35) is strictly positive.

From Proposition 4.2, if parameters satisfy $(1 - \beta) \frac{c}{\gamma} < \frac{k}{q(\theta^\star)} < \frac{c}{\gamma}$ and the worker's bargaining power is sufficiently strong, introducing a mandatory leave policy will increase efficiency, which justifies the government intervention in the labor market.

5 Concluding remarks

In this study, a search-theoretic model of the labor market in which a worker uses temporary leave was investigated. The results showed that introducing a mandatory leave policy can increase efficiency. Although a firm would prefer to lay off a worker who needs to go on leave and then search for a new worker in the labor market because the cost of opening a vacancy is smaller than the cost of maintaining a job for the worker on leave, as long as the cost of opening a vacancy is larger than the cost of maintaining a job that the firm bears in equilibrium, the mandatory leave policy increases efficiency. In such a case, without mandatory leave policy, many unemployed workers are in the labor market, resulting in a labor market that is too loose from an efficiency perspective. Mandatory leave policy increases labor market tightness, increasing efficiency. This result rationalizes the government intervention in the labor market, such as implementing paid and unpaid parental leave policies, from an economic efficiency perspective.

Because the model in this study is simple for tractability, there are many directions in which to extend it. For instance, this study assumed that the labor productivity of a worker on leave does not change even after a worker takes the leave for tractability. In the real world, this assumption might not be true. Thus, it is important to examine whether, even in such an extended model, the same result as that in this study holds.

A Appendix

A.1 Proof of Proposition 3.1

Proof. Plugging the wage equation into the job creation equation, equilibrium labor market tightness is given by

$$(1-\beta)\left[y-b-\frac{\sigma}{r+\gamma}(b-z)-\frac{\sigma}{r+\gamma}c\right] = \left(r+\lambda+\frac{r\sigma}{r+\gamma}\right)\frac{k}{q(\theta)}+\beta\frac{r+\gamma+\sigma}{r+\gamma}\theta k. \tag{36}$$

Notably, the right side of Equation (36) is strictly increasing in θ, and it is zero at $\theta = 0$. Because $y-b-\frac{\sigma}{r+\gamma}(b-z)-\frac{\sigma}{r+\gamma}c > 0$ from Assumption 3.1, there is $\theta^1 > 0$ that satisfies Equation (36). Because $b+\frac{\sigma}{r+\gamma}(b-z) \geq 0$, $y-\beta\frac{\sigma}{r+\gamma}c > 0$, and $\theta^1 > 0$, $w^1 > 0$ from Equation (22). $\qquad\square$

A.2 Proof of Lemma 3.1

Proof. From Equation (3),

$$(r+\gamma)X(y-w^1) = -c+\gamma J(y-w^1).$$

Because $V = 0$ in equilibrium, $V > X(y-w^1)$ if and only if

$$\frac{c}{\gamma} > J(y-w^1).$$

Because $J(y-w^1) = \frac{k}{q(\theta^1)}$ in equilibrium, the above equation is rewritten as $\frac{c}{\gamma} > \frac{k}{q(\theta^1)}$. Notably, because $\sigma \to 0$, the economy with temporary leave shock is converging to the economy without it. This implies that $\theta^1 \to \theta^\star$ as $\sigma \to 0$. Because $q(\theta)$ is continuous in θ, $\frac{k}{q(\theta^1)} \to \frac{k}{q(\theta^\star)}$ as $\sigma \to 0$. Hence, if $\frac{c}{\gamma} > \frac{k}{q(\theta^\star)}$, for sufficiently small σ, $\frac{c}{\gamma} > \frac{k}{q(\theta^1)}$ holds, which implies $V > X(y-w^1)$. Analogously, if $\frac{k}{q(\theta^\star)} > \frac{c}{\gamma}$, for sufficiently small σ, $\frac{k}{q(\theta^1)} > \frac{c}{\gamma}$ holds, which implies $X(y-w^1) > V$ in equilibrium. $\qquad\square$

A.3 Proof of Proposition 3.3

Proof. Plugging the wage equation into the job creation equation, I have

$$(1-\beta)\left[y-b-\frac{\sigma}{r+\gamma}(b-z)\right] = (r+\lambda+\sigma)\frac{k}{q(\theta)}+\beta\frac{r+\gamma+\sigma}{r+\gamma}\theta k, \tag{37}$$

which determines equilibrium labor market tightness. Notably, the right side of Equation (37) is strictly increasing in θ and is zero at $\theta = 0$. Because $y-b-\frac{\sigma}{r+\gamma}(b-z) > 0$, there is $\theta^0 > 0$ that satisfies Equation (37). Since $b+\frac{\sigma}{r+\gamma}(b-z) \geq 0$ and $\theta^0 > 0$, $w^0 > 0$ in equilibrium from Equation (32).

If σ is sufficiently small, $\theta^0 \approx \theta^\star$. Because $q(\theta)$ is continuous in θ, $\frac{k}{q(\theta^\star)} \approx \frac{k}{q(\theta^0)}$. If Equation (25) holds, for sufficiently small $\sigma > 0$, $\frac{k}{q(\theta^0)} < \frac{c}{\gamma}$ holds, which implies $V > X(y-w^0)$. $\qquad\square$

A.4 Proof of Proposition 4.1

Proof. From Equations (18) and (22), the implicit function theorem implies

$$
\begin{pmatrix} \frac{\partial w^1}{\partial \sigma} \\ \frac{\partial \theta^1}{\partial \sigma} \end{pmatrix} = \begin{pmatrix} -1 & \left(r+\lambda+\frac{r\sigma}{r+\gamma}\right)\frac{k}{[q(\theta^1)]^2}q'(\theta^1) \\ 1 & -\beta k\left(1+\frac{\sigma}{r+\gamma}\right) \end{pmatrix}^{-1} \begin{pmatrix} \frac{1}{r+\gamma}\left(c+r\frac{k}{q(\theta^1)}\right) \\ \frac{1}{r+\gamma}\left[\beta(\theta^1 k-c)+(1-\beta)(b-z)\right] \end{pmatrix}. \quad (38)
$$

Analogously, from Equations (29) and (32),

$$
\begin{pmatrix} \frac{\partial w^0}{\partial \sigma} \\ \frac{\partial \theta^0}{\partial \sigma} \end{pmatrix} = \begin{pmatrix} -1 & (r+\lambda+\sigma)\frac{k}{[q(\theta^0)]^2}q'(\theta^0) \\ 1 & -\beta k\left(1+\frac{\sigma}{r+\gamma}\right) \end{pmatrix}^{-1} \begin{pmatrix} \frac{k}{q(\theta^0)} \\ \frac{1}{r+\gamma}\left[\beta\theta^0 k+(1-\beta)(b-z)\right] \end{pmatrix}. \quad (39)
$$

From these equations,

$$
\frac{\partial \theta^0}{\partial \sigma} = \frac{-\frac{1}{r+\gamma}\left[\beta\theta^0 k+(1-\beta)(b-z)\right]-\frac{k}{q(\theta^0)}}{\beta k\left(1+\frac{\sigma}{r+\gamma}\right)-\frac{(r+\lambda+\sigma)k}{[q(\theta^0)]^2}q'(\theta^0)}, \quad (40)
$$

and

$$
\frac{\partial \theta^1}{\partial \sigma} = \frac{-\frac{1}{r+\gamma}\left[\beta(\theta^1 k-c)+(1-\beta)(b-z)\right]-\frac{1}{r+\gamma}\left(c+r\frac{k}{q(\theta^1)}\right)}{\beta k\left(1+\frac{\sigma}{r+\gamma}\right)-\left(r+\lambda+\frac{r\sigma}{r+\gamma}\right)\frac{k}{[q(\theta^1)]^2}q'(\theta^1)}. \quad (41)
$$

Because $q'(\theta) < 0$ for all θ, the signs of denominators of both equations are positive.

Notably, $\theta^0 = \theta^1 = \theta^\star$ at $\sigma = 0$. Evaluating Equations (40) and (41) at $\sigma = 0$, each equation becomes

$$
\left.\frac{\partial \theta^0}{\partial \sigma}\right|_{\sigma=0} = \frac{-\frac{1}{r+\gamma}\left[\beta\theta^\star k+(1-\beta)(b-z)\right]-\frac{k}{q(\theta^\star)}}{\beta k-\frac{(r+\lambda)k}{[q(\theta^\star)]^2}q'(\theta^\star)}, \quad (42)
$$

$$
\left.\frac{\partial \theta^1}{\partial \sigma}\right|_{\sigma=0} = \frac{-\frac{1}{r+\gamma}\left[\beta(\theta^\star k-c)+(1-\beta)(b-z)\right]-\frac{1}{r+\gamma}\left(c+r\frac{k}{q(\theta^\star)}\right)}{\beta k-\frac{(r+\lambda)k}{[q(\theta^\star)]^2}q'(\theta^\star)}. \quad (43)
$$

The denominators in Equations (42) and (43) are the same. Equation (33) implies

$$
-\frac{1}{r+\gamma}\left[\beta\theta^\star k+(1-\beta)(b-z)\right]-\frac{k}{q(\theta^\star)} < -\frac{1}{r+\gamma}\left[\beta(\theta^\star k-c)+(1-\beta)(b-z)\right]-\frac{1}{r+\gamma}\left(c+r\frac{k}{q(\theta^\star)}\right).
$$

Therefore,

$$
\left.\frac{\partial \theta^0}{\partial \sigma}\right|_{\sigma=0} < \left.\frac{\partial \theta^1}{\partial \sigma}\right|_{\sigma=0}.
$$

For sufficiently small $\sigma > 0$,

$$
\theta^1 \approx \theta^\star + \left.\frac{\partial \theta^1}{\partial \sigma}\right|_{\sigma=0}\sigma, \ \theta^0 \approx \theta^\star + \left.\frac{\partial \theta^0}{\partial \sigma}\right|_{\sigma=0}\sigma
$$

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holds, which completes the proof of the "if" part.

For the "only if" part, suppose $\frac{k}{q(\theta^\star)} \leq (1-\beta)\frac{c}{\gamma}$. From the aforementioned argument, $\left.\frac{\partial\theta^0}{\partial\sigma}\right|_{\sigma=0} \geq \left.\frac{\partial\theta^1}{\partial\sigma}\right|_{\sigma=0}$. This implies $\theta^1 \leq \theta^0$ for sufficiently small σ, which completes the proof of the "only if" part.

From Equation (39),

$$\frac{\partial w^0}{\partial\sigma} = \frac{-\frac{k}{q(\theta^0)}\beta k\left(1+\frac{\sigma}{r+\gamma}\right) - (r+\lambda+\sigma)\frac{k}{[q(\theta^0)]^2}q'(\theta^0)\frac{1}{r+\gamma}\left[\beta\theta^0 k + (1-\beta)(b-z)\right]}{\beta k\left(1+\frac{\sigma}{r+\gamma}\right) - \frac{(r+\lambda+\sigma)k}{[q(\theta^0)]^2}q'(\theta^0)}. \tag{44}$$

Evaluating Equation (44) at $\sigma = 0$,

$$\left.\frac{\partial w^0}{\partial\sigma}\right|_{\sigma=0} = \frac{-\frac{k}{q(\theta^\star)}\beta k - (r+\lambda)\frac{k}{[q(\theta^\star)]^2}q'(\theta^\star)\frac{1}{r+\gamma}[\beta\theta^\star k + (1-\beta)(b-z)]}{\beta k - \frac{(r+\lambda)k}{[q(\theta^\star)]^2}q'(\theta^\star)}. \tag{45}$$

Analogously, from Equation (38),

$$\frac{\partial w^1}{\partial\sigma} = \frac{-\beta k\left(1+\frac{\sigma}{r+\gamma}\right)\frac{1}{r+\gamma}\left(c+r\frac{k}{q(\theta^1)}\right) - \left(r+\lambda+\frac{r\sigma}{r+\gamma}\right)\frac{k}{[q(\theta^1)]^2}q'(\theta^1)\frac{1}{r+\gamma}\left(\beta(\theta^1 k - c) + (1-\beta)(b-z)\right)}{\beta k\left(1+\frac{\sigma}{r+\gamma}\right) - \left(r+\lambda+\frac{r\sigma}{r+\gamma}\right)\frac{k}{[q(\theta^1)]^2}q'(\theta^1)}. \tag{46}$$

Evaluating Equation (46) at $\sigma = 0$,

$$\left.\frac{\partial w^1}{\partial\sigma}\right|_{\sigma=0} = \frac{-\frac{\beta k}{r+\gamma}\left(c+r\frac{k}{q(\theta^\star)}\right) - (r+\lambda)\frac{k}{[q(\theta^\star)]^2}q'(\theta^\star)\frac{1}{r+\gamma}[\beta(\theta^\star k - c) + (1-\beta)(b-z)]}{\beta k - \frac{(r+\lambda)k}{[q(\theta^\star)]^2}q'(\theta^\star)}. \tag{47}$$

From Equations (45) and (47), I have

$$\left.\frac{\partial w^1}{\partial\sigma}\right|_{\sigma=0} - \left.\frac{\partial w^0}{\partial\sigma}\right|_{\sigma=0} = \frac{\frac{\beta k}{r+\gamma}\left\{\frac{\gamma k}{q(\theta^\star)} - c\left[1 - \frac{r+\lambda}{[q(\theta^\star)]^2}q'(\theta^\star)\right]\right\}}{\beta k - \frac{(r+\lambda)k}{[q(\theta^\star)]^2}q'(\theta^\star)}. \tag{48}$$

Notably, because $q'(\theta) < 0$, the denominator of Equation (48) is positive. Moreover, $1 - \frac{r+\lambda}{[q(\theta^\star)]^2}q'(\theta^\star) > 1$. Hence, if $c > \frac{\gamma k}{q(\theta^\star)} > (1-\beta)c$, $\frac{\gamma k}{q(\theta^\star)} - c\left[1 - \frac{r+\lambda}{[q(\theta^\star)]^2}q'(\theta^\star)\right] < 0$. This implies that for sufficiently small $\sigma > 0$, $w^0 > w^1$ in equilibrium. $\square$

A.5 Proof of Lemma 4.1

Proof. In equilibrium, $u^0 > u^1$, $e^1 > e^0$, and $l^1 > l^0$ if and only if

$$(\lambda + \sigma)\theta^1 q(\theta^1) > \lambda\theta^0 q(\theta^0). \tag{49}$$

Because $\theta q(\theta)$ is strictly increasing in θ, $\theta^1 > \theta^0$ implies $\theta^1 q(\theta^1) > \theta^0 q(\theta^0)$. Because $\sigma > 0$, Equation (49) holds, which completes the proof. $\square$

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A.6 Proof of Proposition 4.2

Proof. Because $(e^0, u^0, l^0, \theta^0)$ and $(e^1, u^1, l^1, \theta^1)$ are time-invariant, $W^1 > W^0$ holds if and only if

$$S = (e^1 - e^0)y + [u^1(b - \theta^1 k) - u^0(b - \theta^0 k)] + (l^1 - l^0)z - l^1 c > 0 \tag{50}$$

holds. Taking the derivative of each term in Equation (50) with respect to σ and evaluating it at $\sigma = 0$, I obtain

$$\left(\left. \frac{\partial e^1}{\partial \sigma} \right|_{\sigma=0} - \left. \frac{\partial e^0}{\partial \sigma} \right|_{\sigma=0} \right) y = \left\{ \frac{\lambda[q(\theta^\star) + \theta^\star q'(\theta^\star)]}{[\lambda + \theta^\star q(\theta^\star)]^2} \left(\left. \frac{\partial \theta^1}{\partial \sigma} \right|_{\sigma=0} - \left. \frac{\partial \theta^0}{\partial \sigma} \right|_{\sigma=0} \right) + \frac{\theta^\star q(\theta^\star)}{[\lambda + \theta^\star q(\theta^\star)]^2} \right\} y,$$

$$\left(\left. \frac{\partial[u^1(b - \theta^1 k)]}{\partial \sigma} \right|_{\sigma=0} - \left. \frac{\partial[u^0(b - \theta^0 k)]}{\partial \sigma} \right|_{\sigma=0} \right) = -(b - \theta^\star k)\frac{\theta^\star q(\theta^\star)}{[\lambda + \theta^\star q(\theta^\star)]^2}$$

$$- (b - \theta^\star k)\frac{\lambda[q(\theta^\star) + \theta^\star q'(\theta^\star)]}{[\lambda + \theta^\star q(\theta^\star)]^2} \left(\left. \frac{\partial \theta^1}{\partial \sigma} \right|_{\sigma=0} - \left. \frac{\partial \theta^0}{\partial \sigma} \right|_{\sigma=0} \right)$$

$$- u^\star k \left(\left. \frac{\partial \theta^1}{\partial \sigma} \right|_{\sigma=0} - \left. \frac{\partial \theta^0}{\partial \sigma} \right|_{\sigma=0} \right),$$

$$\left(\left. \frac{\partial l^1}{\partial \sigma} \right|_{\sigma=0} - \left. \frac{\partial l^0}{\partial \sigma} \right|_{\sigma=0} \right) z = 0,$$

and

$$\left. \frac{\partial l^1}{\partial \sigma} \right|_{\sigma=0} c = \frac{\theta^\star q(\theta^\star)}{\lambda + \theta^\star q(\theta^\star)} \frac{c}{\gamma}.$$

Therefore,

$$\left. \frac{\partial S}{\partial \sigma} \right|_{\sigma=0} = \frac{\theta^\star q(\theta^\star)}{[\lambda + \theta^\star q(\theta^\star)]^2} \left\{ y - b + \theta^\star k - [\lambda + \theta^\star q(\theta^\star)]\frac{c}{\gamma} \right\}$$

$$+ \frac{\lambda[q(\theta^\star) + \theta^\star q'(\theta^\star)]}{[\lambda + \theta^\star q(\theta^\star)]^2} \left\{ y - b + \theta^\star k - \frac{\lambda + \theta^\star q(\theta^\star)}{q(\theta^\star) + \theta^\star q'(\theta^\star)}k \right\} \left(\left. \frac{\partial \theta^1}{\partial \sigma} \right|_{\sigma=0} - \left. \frac{\partial \theta^0}{\partial \sigma} \right|_{\sigma=0} \right),$$

where $u^\star = \frac{\lambda}{\lambda + \theta^\star q(\theta^\star)}$ is applied here. Notably, $q(\theta^\star) + \theta^\star q'(\theta^\star) = q(\theta^\star)\left[1 + \frac{\theta^\star}{q(\theta^\star)}q'(\theta^\star)\right] > 0$, because $-1 < \frac{\theta^\star}{q(\theta^\star)}q'(\theta^\star) < 0$.

From Equation (23), $y - b = \frac{r+\lambda}{1-\beta}\frac{k}{q(\theta^\star)} + \frac{\beta}{1-\beta}\theta^\star k$. Then,

$$y - b + \theta^\star k - [\lambda + \theta^\star q(\theta^\star)]\frac{c}{\gamma} = \frac{r+\lambda}{1-\beta}\left[\frac{k}{q(\theta^\star)} - \frac{(1-\beta)\lambda}{r+\lambda}\frac{c}{\gamma}\right] + \frac{\theta^\star q(\theta^\star)}{1-\beta}\left[\frac{k}{q(\theta^\star)} - (1-\beta)\frac{c}{\gamma}\right] \tag{51}$$

and

$$y - b + \theta^\star k - \frac{\lambda + \theta^\star q(\theta^\star)}{q(\theta^\star) + \theta^\star q'(\theta^\star)}k = \left[\frac{r+\lambda}{1-\beta} - \frac{\lambda}{1-\eta(\theta^\star)}\right]\frac{k}{q(\theta^\star)} + \left[\frac{1}{1-\beta} - \frac{1}{1-\eta(\theta^\star)}\right]\theta^\star k, \tag{52}$$

where $\eta(\theta^\star) := -\frac{\theta^\star}{q(\theta^\star)}q'(\theta^\star) > 0$. If $\frac{k}{q(\theta^\star)} > (1-\beta)\frac{c}{\gamma}$ holds, then $\frac{k}{q(\theta^\star)} > \frac{\lambda}{r+\lambda}(1-\beta)\frac{c}{\gamma}$, because $\frac{\lambda}{r+\lambda} < 1$. This implies that Equation (51) is greater than 0. If $\beta \geq \eta(\theta^\star)$, then $\frac{1}{1-\beta} \geq \frac{1}{1-\eta(\theta^\star)}$ and $\frac{r+\lambda}{1-\beta} > \frac{\lambda}{1-\eta(\theta^\star)}$ hold. Therefore, Equation (52) is greater than 0. Hence, $\left. \frac{\partial S}{\partial \sigma} \right|_{\sigma=0} > 0$, which completes the proof. $\square$

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