

**LABOR MARKET INSTITUTIONS AND  
EMPLOYMENT FLUCTUATIONS IN DYNAMIC  
GENERAL EQUILIBRIUM MODELS**

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**January 2017**

**Discussion Paper No.1701**

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# LABOR MARKET INSTITUTIONS AND EMPLOYMENT FLUCTUATIONS IN DYNAMIC GENERAL EQUILIBRIUM MODELS

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## ABSTRACT

Labor market reforms have been undertaken to eliminate labor market rigidities in European countries since 1970s. The important features of the reforms are the reduction in adjustment costs and the introduction of fixed-term contracts (FTC). In recent years, the substantial decreases in unemployment rates have not been observed. On the other hand, some empirical studies point out employment fluctuations become more volatile after the reforms. This paper presents two types of dynamic general equilibrium models and analyses effects of the key features of the reforms: One is the model with FTC and the other is the model with indefinite-term contracts (ITC). In the model with ITC, total employment and new hiring do not behave cyclically if an expected shock takes place. However, in the model with FTC, the shock causes the cyclical behavior of employment. Moreover, a reduction in adjustment costs amplifies fluctuations in both of the models. In the labor market literature, a number of studies point out importance of trade unions in European countries. This paper also analyses effects of union influence, and indicates that the stronger union influence leads to larger employment fluctuations.

*Keywords:* employment fluctuations, fixed-term contracts, trade unions, labor market reforms

*JEL Classifications numbers:* E24, J30, J51, J63

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## 1. INTRODUCTION

Labor market institutions are one of the most influential factors in macroeconomic dynamics. For a persistent high unemployment rate in the European countries, labor market reforms have been undertaken to eliminate the labor market rigidities since 1970s. Faccini (2013) and Giannelli *et al.* (2012) point out that important features of the reforms are reduction in adjustment costs and introduction to fixed-term contracts (FTC).<sup>1</sup> However, substantial decreases in unemployment rates were not observed. Alonso-Borrego *et al.* (2005) and Jiménez-Rodríguez and Russo (2012) indicate that employment fluctuations become more volatile after the reforms. Moreover, De Serres and Murtin (2013) and OECD (2012) show that increase in the share of FTC amplifies the employment fluctuations.

In the dynamic labor demand literature, adjustment cost models are widely used.<sup>2</sup> In the models, it can be considered that indefinite-term contracts (ITC) are assumed. Matsue and Nakamura (2016) and Matsue (2016) create two types of dynamic labor demand models: One is a model with FTC and the other is a model with ITC. They show that the FTC and ITC models are different in terms of property of employment dynamics. In the ITC model, total employment and new hiring do not behave cyclically if an expected productivity shock takes place, while the shock causes the cyclical behavior of employment in the FTC model.

Layard *et al.* (2005) discuss an importance of trade union in the European labor market. Union membership ratio and coverage ratio are proxy variables for influence of trade union on wage setting or union power. The union membership ratio has been recently declining in European countries, whereas the union coverage ratio is still high, as shown in OECD (2015). Booth (2014) argues, using French data, that the coverage ratio is a better measure of union influence than union membership ratio.

A relationship between union influence and unemployment rates has been investigated extensively in the research of business cycles. Faccini and Bondibene (2012) and Gnocchi *et al.* (2015) analyze a relationship between some labor market institutions and cyclical behavior of unemployment rates for OECD countries. Faccini and Bondibene indicate that increase in the coverage ratio amplifies cyclical fluctuations of unemployment rates, whereas Gnocchi *et al.* do not show statistically significant results about this relationship.

First, we present two types of dynamic general equilibrium models and compare dynamics of

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<sup>1</sup>Jiménez-Rodríguez and Russo (2012) precisely study the regulations about FTC of recent years for major European countries.

<sup>2</sup>Hamermesh and Pfann (1996) thoroughly explain the property of the adjustment cost model.

these two models: One is the model with FTC and the other is the model with ITC. Similarly to the dynamic labor demand models, total employment and new hiring do not behave cyclically if an expected productivity shock takes place in the model with ITC, while the shock causes the cyclical behavior of employment in the model with FTC. Zipperer and Skott (2011) exhibit cyclical employment trend with short-run cycles in French and Spanish economies, which is consistent with simulation results in this paper.

Second, this study analyzes relationship between union influence and employment dynamics in the models by using simulation analysis. The simulation results show that the stronger union influence on wages leads to larger employment fluctuations in both the FTC and ITC models. The strong union influence puts an upward pressure on wage rates. Then, firms need to adjust its employment significantly when the productivity shock takes place. This is consistent with the results of Faccini and Bondibene (2012).

Third, this study examines relationship between elasticity of wage with respect to employment rate and employment dynamics. The higher elasticity of wage with respect to the employment rate leads to smaller employment fluctuations in both the FTC and ITC models. The firms do not need to adjust employment largely because wage varies significantly when the elasticity of wage with respect to the employment rate is high.

The rest of this paper is organized as follows. Section 2 sets up the general equilibrium models. Section 3 discusses the property of the models with simulation analysis. Section 4 investigates the influence of the labor supply side on employment fluctuations. Section 5 concludes the paper.

## 2. MODEL

Consider two types of dynamic general equilibrium models: One is the model with fixed-term contracts (FTC) and the other is the model with indefinite-term contracts (ITC). The difference between the two models is only the types of contracts. In the dynamic labor demand literature, adjustment cost models are widely used. In this study, the ITC model is the extension of the adjustment cost model.

### *2.1 FTC model*

Let us set up the model with FTC. Firms plan their production during the finite time period  $T$ , and they produce homogeneous goods. The objective function is as follows:

$$\max_{h_t, K_t} \sum_{t=0}^T \beta^t [(A_t L_t)^\alpha K_t^{1-\alpha} - w_t L_t - (r_t + \delta) K_t - (\tau/2) h_t^2], \quad (1)$$

where  $0 < \beta < 1$  is discount factor,  $A_t$  is positive productivity parameter,  $L_t$  is total employment,  $h_t$  is new hiring, and  $K_t$  is capital. Moreover,  $w_t$  is wage rate,  $r_t$  is rental price of capital, and  $(\tau/2)h_t^2$ , where  $\tau \geq 0$  is labor adjustment cost function. Suppose that a firm makes an agreement for an FTC with labor, in which the term of contracts is two periods. The total employment is as follows:

$$L_t = h_{t-1} + h_{t-2}. \quad (2)$$

Then,  $h_{-2}$ ,  $h_{-1}$ , and  $K_0$  are given. It is assumed that the firm hires constant  $L_T \geq 0$  as given. Additionally,  $K_T \geq 0$  is given. The firm decides  $h_t$  from period 0 to  $T-3$  and  $K_t$  from period 1 to  $T-1$ . The first-order conditions are as follows:

$$\sum_{s=t}^{t+1} \beta^s \alpha A_s l_s^{\alpha-1} = \sum_{s=t}^{t+1} \beta^s w_s + \beta^{t-1} \tau h_{t-1}, \quad t=1, 2, \dots, T-2, \quad (3)$$

$$(1-\alpha)l_t^\alpha = r_t + \delta, \quad t=1, 2, \dots, T-1, \quad (4)$$

where  $l_t \equiv A_t L_t / K_t$ .

Similar to Blanchard (1997), suppose that the wage setting equation is as follows:

$$w_t = \theta \left( \frac{L_t}{N} \right)^\gamma, \quad (5)$$

where  $N$  denotes labor force in this economy that is assumed constant,  $\theta$  is wage at zero unemployment, and  $\gamma \geq 1$  is wage elasticity with respect to employment rate  $L_t/N$ .<sup>3</sup> It is assumed that  $L_t < N$  to analyze employment fluctuations. The increase in  $\theta$  exerts an upward pressure on the wage rate.<sup>4</sup> Hence,  $\theta$  could be interpreted as a union influence on wage. Equation (5) is transformed as follows:

$$w_t = \theta \left( \frac{l_t}{n_t} \right)^\gamma, \quad (6)$$

where  $n_t \equiv A_t N / K_t$ . From equations (3) and (6), we obtain the following equation:

$$\sum_{s=t}^{t+1} \beta^s \alpha A_s l_s^{\alpha-1} = \sum_{s=t}^{t+1} \beta^s \theta \left( \frac{l_s}{n_s} \right)^\gamma + \beta^{t-1} \tau h_{t-1}. \quad (7)$$

Equation (7) is rewritten as follows:

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<sup>3</sup>In the wage setting equation, it is assumed that the wage is an increasing function of the employment rate. Adachi and Nakamura (2015) point out that this relationship is justified by wage bargaining theory or efficiency wage theory. The wage bargaining theory and efficiency wage theory are thoroughly discussed in Layard *et al.* (2005).

<sup>4</sup>Blanchflower and Bryson (2002), and Nickell (1997) point out that the union puts an upward pressure on the wage rate.

$$\frac{l_t}{n_t} = \left[ \frac{\alpha\beta A_t l_t^{\alpha-1} + \alpha\beta^2 A_{t+1} l_{t+1}^{\alpha-1} - \beta^2 \theta (l_{t+1}/n_{t+1})^\gamma - \theta h_{t-1}}{\beta\theta} \right]^{\frac{1}{\gamma}}, \quad (8)$$

which is employment rate. Then, unemployment rate is as follows:

$$\frac{N - L_t}{N} = 1 - \frac{l_t}{n_t}. \quad (9)$$

Households own firms, and they save and invest a fixed fraction  $s$  of production  $Y_t$ :

$$I_t = sY_t, 0 < s < 1. \quad (10)$$

Suppose that equation for capital dynamics with depreciation rate  $\delta$  is as follows:

$$K_{t+1} = K_t + I_t - \delta K_t. \quad (11)$$

From equations (10), (11), and the production function, the capital dynamics is as follows:

$$K_{t+1} = s l_t^\alpha K_t + (1 - \delta) K_t. \quad (12)$$

The equilibrium is determined by equations (2), (7), (12), the initial conditions, and termination conditions. Now, consider the steady state:  $h_{t+1} = h_t = h$ ,  $L_{t+1} = L_t = L$ , and  $K_{t+1} = K_t = K$ , that is  $l_{t+1} = l_t = l$ ,  $n_{t+1} = n_t = n$ . Further, it is assumed that  $A_{t+1} = A_t = A$ , then equations (2), (7), and (12) are transformed as follows:

$$h = \frac{1}{2} L, \quad (13)$$

$$l = \left[ \frac{(1 + \beta)\beta\theta(L/N)^\gamma + \theta h}{(1 + \beta)\alpha\beta A} \right]^{\frac{-1}{1-\alpha}}, \quad (14)$$

$$l = \left( \frac{\delta}{s} \right)^{\frac{1}{\alpha}}. \quad (15)$$

Equation (13) indicates that the new hiring is as much as the labor that leaves a job in the steady state. From equation (11), the investment equal to the depreciation at the steady state. In addition, the investment is determined as a fixed fraction  $s$  of production. Hence,  $l$  is determined by saving rate and depreciation rate as shown in equation (15). From equations (13)–(15), we obtain the steady state values  $h^*$ ,  $L^*$ , and  $l^*$ . Moreover, from  $l = AL/K$ , equation (15) is transformed as follows:

$$K = \left( \frac{s}{\delta} \right)^{\frac{1}{\alpha}} AL. \quad (16)$$

If we substitute  $L^*$  into equation (16), we obtain the steady state value  $K^*$ .

## 2.2 ITC model

To understand the role of FTC, the FTC model should be compared with a labor adjustment cost model, that is, the ITC model in this study. The labor adjustment cost model is widely used in the

dynamic labor demand literature. It is assumed that employees leave their job by a fixed fraction  $0 < \sigma < 1$  of total employment. The employment dynamics is as follows:

$$L_t = (1 - \sigma)L_{t-1} + h_{t-1}, \quad (17)$$

where  $\sigma$  is turnover rate. The firm optimizes objective function (1), subject to the constraint of equation (17), where the initial conditions  $(L_0, K_0)$  and the terminal conditions  $(L_T, K_T)$  are given. The firm decides  $h_t$  from period 0 to  $T-2$  and  $K_t$  from period 1 to  $T-1$ . The first-order conditions are as follows:

$$\alpha\beta A_t l_t^{\alpha-1} + \beta(1-\sigma)\mathcal{H}_{t+1} = \beta w_t + \mathcal{H}_t, \quad t=1, 2, \dots, T-1, \quad (18)$$

$$(1-\alpha)l_t^\alpha = r_t + \delta, \quad t=1, 2, \dots, T-1. \quad (19)$$

Similar to the FTC model, consider the employment rate. From equations (6) and (18), we obtain as follows:

$$\alpha\beta A_t l_t^{\alpha-1} + \beta(1-\sigma)\mathcal{H}_{t+1} = \beta\theta \left( \frac{l_t}{n_t} \right)^\gamma + \mathcal{H}_t. \quad (20)$$

Transform equation (20), then the employment rate is obtained as follows:

$$\frac{l_t}{n_t} = \left[ \frac{\alpha\beta A_t l_t^{\alpha-1} + (1-\sigma)\mathcal{H}_{t+1} - \mathcal{H}_t}{\beta\theta} \right]^{\frac{1}{\gamma}}. \quad (21)$$

Unemployment rate is obtained by substituting equation (21) into equation (9). The household behavior is the same with the FTC model. Hence, the equilibrium is determined by equations (12), (17), (20), the initial conditions, and termination conditions. At the steady state, equations (12), (17), and (20) are as follows:

$$h = \sigma L, \quad (22)$$

$$l = \left[ \frac{\beta\theta(L/N)^\gamma + \{1 - \beta(1-\sigma)\}\mathcal{H}}{\alpha\beta A} \right]^{\frac{-1}{1-\alpha}}, \quad (23)$$

$$l = \left( \frac{\delta}{s} \right)^{\frac{1}{\alpha}}. \quad (24)$$

Equation (22) shows that the new hiring is as much as the labor that leaves a job in the steady state. From equations (22)–(24), we obtain the steady state values  $h^*$ ,  $L^*$ , and  $l^*$ . From  $l = AL/K$ , equation (24) is rewritten as follows:

$$K = \left( \frac{s}{\delta} \right)^{\frac{1}{\alpha}} AL. \quad (25)$$

Then, by substituting  $L^*$  into equation (25), we obtain the steady state value  $K^*$ . Compare equations (13)–(15) with equations (22)–(24); if  $\tau=0$  and  $\sigma=1/2$ , then the steady state values between the two models are the same.

### 3. MODEL PROPERTIES

Now, we analyze effects of an expected productivity shocks on employment by running some simulations. The shocks are either temporary or permanent, which decreases one percent of the total employment. Similar to Matsue and Nakamura (2016) and Matsue (2016) that are dynamic labor demand models, the ITC model does not show cyclical employment behavior, while the FTC model shows it regardless of the shock type.

#### 3.1 Property of FTC model

In this section, we consider fluctuations in employment for an expected productivity shocks with the FTC model. We set the parameter values as shown in Table 1.<sup>5</sup> In the beginning of planning period, the economy is at the steady state. Then, it is assumed that the total employment is 100 ( $L_0 = 100$ ). Thus, half of  $L_0$  is the new hiring at period  $-1$  and the other half is the new hiring at period  $-2$  ( $h_{-1} = h_{-2} = 50$ ). Suppose that the shocks take place at period 15, and  $T = 50$ . Here, negative shocks to productivity are expected, which decreases one percent of the total employment at period 15. We assume two types of shocks: one is a temporary shock and the other is permanent shock. The former takes place at period 15 and then it returns at period 16. The latter takes place at period 15 and then stays at that level forever. The initial productivity level  $A_0$  is chosen by having  $L_0 = 100$ .<sup>6</sup> The initial capital  $K_0$  is chosen by substituting  $A_0$  and  $L_0 = 100$  into equation (16). If the shock is temporary, the terminal conditions are  $L_{50} = 100$  and  $K_{50} = K_0$ . If the shock is permanent, the terminal condition is  $L_{50} = 99$ . In addition, the terminal condition  $K_{50}$  is chosen by substituting  $L_{50} = 99$  and  $A_{50}$  into equation (16). Then, similar to the initial condition,  $A_{50}$  is chosen by substituting  $L = 99$  and  $h = 49.5$  into the equation given by (14) and (15) (see footnote 5).

[Table 1 about here]

Figures 1 and 2 show the simulation results with the temporary shock. The solid lines show the optimum paths when the negative shock takes place, while the dotted lines show the optimum paths when no shock takes place. These figures show that the fluctuations are cyclical even if the firm does not incur the adjustment costs.

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<sup>5</sup>We set the parameters  $\gamma$  and  $\theta$  that are in the wage setting equation to the same values in Blanchard (1997). The parameters  $\alpha$  and  $s$  are the same values used in Novales *et al.* (2010) chapter 2.

<sup>6</sup>From equations (14) and (15), we have  $A = [(1 + \beta)\beta\theta(L/N)^\gamma + \theta h] / [(1 + \beta)\alpha\beta(s/\delta)^{(1-\alpha)/\alpha}]$ . Substitute  $L = 100$  and  $h = 50$  into this equation, then the initial productivity level with FTC case is obtained.



If the negative shock takes place at period 15, the firm decreases new hiring at periods 13 and 14 ( $h_{13}$  and  $h_{14}$ ) in order to adjust total employment at period 15 ( $L_{15}$ ). Then, the firm faces less employment than the optimum employment at periods 14 ( $L_{14}$ ) and 16 ( $L_{16}$ ). Therefore, it increases  $h_{12}$  and  $h_{15}$  to avoid falling into the condition, because  $L_{14} = h_{13} + h_{12}$  and  $L_{16} = h_{15} + h_{14}$ . These decisions cause increase in the total employment at periods 13 and 17. Hence, the firm decreases new hiring at periods 11 and 16. These decisions are repeated throughout the planning period. Then, the employment and the new hiring behave cyclically. With the adjustment cost case, the behavior is smaller than the no adjustment cost case. This is because the adjustment costs play a role in smoothing the labor adjustments.

[Fig. 1 about here]

[Fig. 2 about here]

With the permanent shock cases, similar to the temporary cases, the cyclical behavior is observed as shown in Figures 3 and 4. If the negative permanent shock takes place at period 15, the firm decreases  $h_{13}$  and  $h_{14}$  in order to decrease  $L_{15}$ . Then, the firm increases  $h_{12}$  and  $h_{15}$  in order to avoid less employment. After that, as is the case with the temporary case, the new hiring is adjusted by avoiding overemployment and underemployment within the planning period. In the FTC model, the shock causes the cyclical behavior of employment in not only the temporary case but also the permanent case. Moreover, cyclical behavior of capital and production are observed.

[Fig. 3 about here]

[Fig. 4 about here]

### 3.2 Property of ITC model

To compare with the FTC model, let us consider the ITC model. The assumptions about the shocks are similar to the case with the FTC model. Table 1 shows the parameter values.

In the beginning of the planning period, the economy is at the steady state. Then, it is assumed that  $L_0 = 100$ . In order to compare with the FTC model, at the steady state, half of the total employment leaves the job at the end of the period ( $\sigma = 0.5$ ). Then, equation (13) is equal to equation (22). Moreover, the new hiring and total employment between the two models with no adjustment costs are the same at the steady state.

$A_0$  is chosen by having  $L_0 = 100$ .<sup>7</sup>  $K_0$  is chosen by substituting  $A_0$  and  $L_0 = 100$  into

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<sup>7</sup>From equations (23) and (24), we have  $A = [\beta\theta(L/N)^\gamma + \{1 - \beta(1 - \sigma)\}h] / [\alpha\beta(s/\delta)^{(1-\alpha)/\alpha}]$ . Substitute  $L = 100$  and  $h = 50$  into this equation, then the initial productivity level with ITC case is obtained.

equation (25). If the shock is temporary, the terminal conditions are  $L_{50}=100$  and  $K_{50}=K_0$ . If the shock is permanent, the terminal condition is  $L_{50}=99$ . Moreover, the terminal condition  $K_{50}$  is chosen by substituting  $L_{50}=99$  and  $A_{50}$  into equation (25). Then, similar to the initial condition,  $A_{50}$  is chosen by substituting  $L=99$  and  $h=49.5$  into equations (23) and (24) (see footnote 6).

Figures 5 and 6 show the simulation results with temporary shocks. The solid lines show the optimum paths when an anticipated negative shock takes place, while the dotted lines show the optimum paths when no shock takes place.

In the ITC case, preparing for the negative shock at period 15, the firm decreases the new hiring at period 14 in order to decrease the total employment at period 15. The adjustment cost makes the fluctuations smooth. Different from the FTC case, these figures do not show the cyclical behavior.

[Fig. 5 about here]

[Fig. 6 about here]

With the permanent shock cases, similar to the temporary cases, the cyclical behavior is not observed in Figures 7 and 8. Further, the fluctuations are smooth if the firm incurs the adjustment costs.

[Fig. 7 about here]

[Fig. 8 about here]

*Proposition 1*

In the ITC model, the total employment and new hiring do not behave cyclically if an expected shock that is either temporary or permanent takes place. However, in the FTC model, the shock causes the cyclical behavior of employment even if the firm does not incur any adjustment costs. The FTC and ITC models are different about the property of employment dynamics.

#### 4. LABOR SUPPLY AND EMPLOYMENT FLUCTUATIONS

In this section, we run some simulations to analyze an effect of labor supply side on employment dynamics in the models. That is, a relationship between union influence  $\theta$  and employment dynamics, and a relationship between elasticity of wage with respect to employment rate  $\gamma$  and employment dynamics. These parameters are included in the wage setting function. Additionally, we assume that the firm incurs adjustment costs  $\tau = 0.01$ . The other parameters about the simulations

are the same in the Table 1.

#### 4.1 Relationship between union influence and employment dynamics

We analyze a relationship between union influence  $\theta$  and employment dynamics in the FTC model and the ITC model. Suppose that an expected negative shock to productivity takes place at period 15, which decreases one percent of the productivity at period 15. The shock is temporary, i.e. the level of productivity decreases at period 15 and then it returns at period 16. In the beginning of the planning period, the economy is at the steady state.

First, let us consider the FTC case. Figure 9 shows the simulation results for the FTC model. The solid lines show the difference between the optimum paths of employment when the negative shock takes place and the optimum paths when no shock takes place, while the dotted lines show the changes in optimum paths when no shock takes place.  $A_0$  is chosen by having  $L_0 = 100$ . Hence, the level of  $A_0$  is different depending on the level of  $\theta$ .<sup>8</sup> The cyclical behavior is observed near the shock period when  $\theta = 0.35$ , while it is observed widely when  $\theta = 2$ . The four figures in Figure 9 show that the stronger union influence leads to larger cyclical behavior.

[Fig. 9 about here]

In this model, we assume  $N = L_t + U_t$  and the unemployment rate is defined as equation (9), where  $N$  is constant. Thus, the stronger union influence leads to the large cyclical behavior of unemployment rate. This result is consistent with the empirical results in Faccini and Bondibene (2012). The increase in  $\theta$  puts upward pressure on the wage rate. Hence, the firm adjusts employment significantly when the productivity shock takes place.

Next, Figure 10 shows the simulation results with the ITC model. It is assumed that the economy is at the steady state in the beginning of the planning period. Then, we set the steady state value of employment is  $L_0 = 100$ .<sup>9</sup> Suppose that the anticipated temporary shock takes place at period 15. The solid lines and the dotted lines mean the same as in Figure 9. Similar to the FTC case, the four figures in Figure 10 show that the stronger union influence leads to larger employment dynamics. Meanwhile, the cyclical behavior is not observed.

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<sup>8</sup>From equations (14) and (15), we have  $A = [(1 + \beta)\beta\theta(L/N)^\gamma + \mathcal{H}] / [(1 + \beta)\alpha\beta(s/\delta)^{(1-\alpha)/\alpha}]$ . Substitute  $L = 100$  and  $h = 50$  into this equation, then the initial productivity level with FTC case is obtained. If we assume a large  $\theta$ , we have a large initial productivity level.

<sup>9</sup>From equations (23) and (24), we have  $A = [\beta\theta(L/N)^\gamma + \{1 - \beta(1 - \sigma)\}\mathcal{H}] / [\alpha\beta(s/\delta)^{(1-\alpha)/\alpha}]$ . Substitute  $L = 100$  and  $h = 50$  into this equation, then the initial productivity level with ITC case is obtained. Similarly to the FTC case, if we assume a large  $\theta$ , we have a large initial productivity level.

[Fig. 10 about here]

*Proposition 2*

Suppose that an expected temporary productivity shock takes place. Then, the stronger the union influence on wage leads to larger employment fluctuations in both the FTC and ITC models.

*4.2 Relationship between elasticity of wage with respect to employment rate and employment dynamics*

We analyze a relationship between elasticity of wage with respect to employment rate  $\gamma$  and employment dynamics in the FTC model and the ITC model. It is assumed that an expected negative shock to productivity takes place at period 15, which decreases one percent of the productivity at period 15. Moreover, the shock is temporary. The assumption of the simulations is the same as in the previous section, except for the assumption about the elasticity of wage with respect to employment rate  $\gamma$ .<sup>10</sup> Figure 11 shows the simulation results with the FTC case.

[Fig. 11 about here]

It shows that the increase in  $\gamma$  causes the decrease in employment fluctuations. Suppose that the elasticity of wage with respect to the employment rate is high. Then, the firm does not need to adjust employment largely because the wage varies significantly when the shock takes place.

Figure 12 shows the simulation results with the ITC case. As is the case with FTC, the higher elasticity of wage with respect to the employment rate leads to smaller employment fluctuations.

[Fig. 12 about here]

*Proposition 3*

Suppose that an expected temporary productivity shock takes place. Then, the higher elasticity of wage with respect to the employment rate leads to smaller employment fluctuations in both the FTC and ITC models.

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<sup>10</sup>From equations (14) and (15), we have  $A = [(1 + \beta)\beta\theta(L/N)^\gamma + \tau h] / [(1 + \beta)\alpha\beta(s/\delta)^{(1-\alpha)/\alpha}]$ . Substitute  $L = 100$  and  $h = 50$  into this equation, then the initial productivity level with FTC case is obtained. Moreover, in the ITC case, from equations (23) and (24), we have  $A = [\beta\theta(L/N)^\gamma + \{1 - \beta(1 - \sigma)\}\tau h] / [\alpha\beta(s/\delta)^{(1-\alpha)/\alpha}]$ . Substitute  $L = 100$  and  $h = 50$  into this equation, then the initial productivity level is obtained. If we assume a high  $\gamma$ , a small initial productivity level is obtained, because we suppose that  $L < N$ .

## 5. CONCLUDING REMARKS

Unemployment and employment dynamics have been studied in many theoretical and empirical analyses. The labor market institutions are one of the most influential factors in macroeconomic dynamics. This study analyzes the impact of labor market institutions on employment fluctuations by employing two types of dynamic general equilibrium models: One is the model with fixed-term contracts (FTC) and the other is the model with indefinite-term contracts (ITC). The FTC model and ITC model have different properties in terms of employment dynamics. In the ITC model, the total employment and new hiring do not behave cyclically if an expected shock takes place, while the shock causes the cyclical behavior of employment in the FTC model. Moreover, the reduction in adjustment cost amplifies the fluctuations in the models.

The union influence in the labor market is important because the union coverage ratio is still at a high level. This study also analyzes the relationship between the union influence and employment dynamics in the models with simulation analysis. The simulation results show that the stronger union influences on wage leads to larger employment fluctuations in both the FTC and ITC models. The strong union influence puts upward pressure on the wage rate. Then, the firm needs to adjust its employment significantly when the productivity shock takes place, which is consistent with the results of Faccini and Bondibene (2012). In this case, the cyclical behavior is observed only in the FTC model.

Further, this study analyzes additional influence of the labor supply side on employment fluctuations. The higher elasticity of wage with respect to the employment rate leads to smaller employment fluctuations in both the FTC and ITC models. The firm does not need to adjust its employment largely because the wage varies significantly when the elasticity of wage with respect to the employment rate is high.

Nevertheless, the FTC model in this study is restricted to a simple case in which the term of contracts is only two periods. Hence, it is necessary to analyze a more general case. Moreover, the models could be extended to consider the endogenous labor supply and intertemporal optimization of consumption. Further investigation of these issues remains to be undertaken.

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Table 1

*Parameters in the simulations*

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$\alpha$	Parameter in production function	0.64
$\beta$	Discount factor	0.99
$\gamma$	Elasticity of wage with respect to employment rate	1.0
$\delta$	Depreciation rate	0.25
$\sigma$	Turnover rate	0.50
$\theta$	Wage at zero unemployment	0.35
$\tau$	Adjustment cost	0.0 or 0.01
$s$	Saving rate	0.30
$N$	Labor force	110.0

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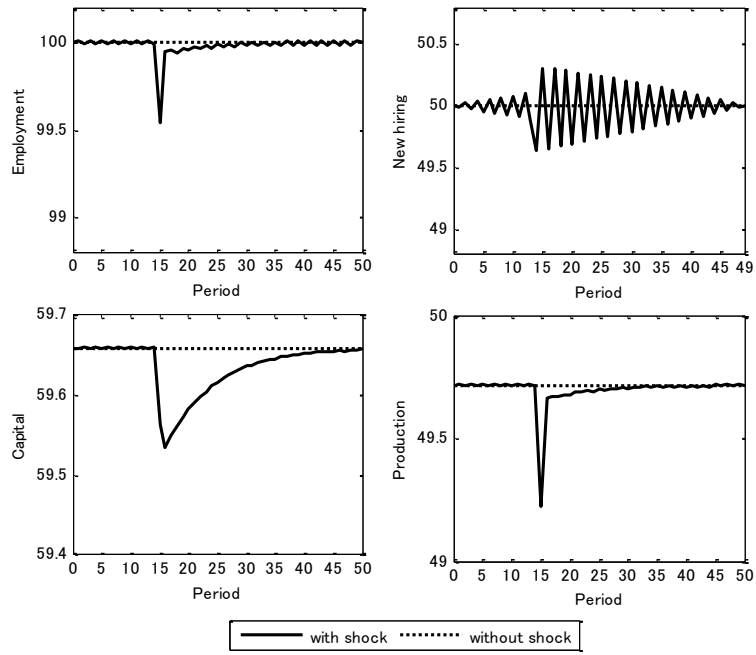


Fig. 1. FTC model with  $\tau = 0$  (temporary shock).

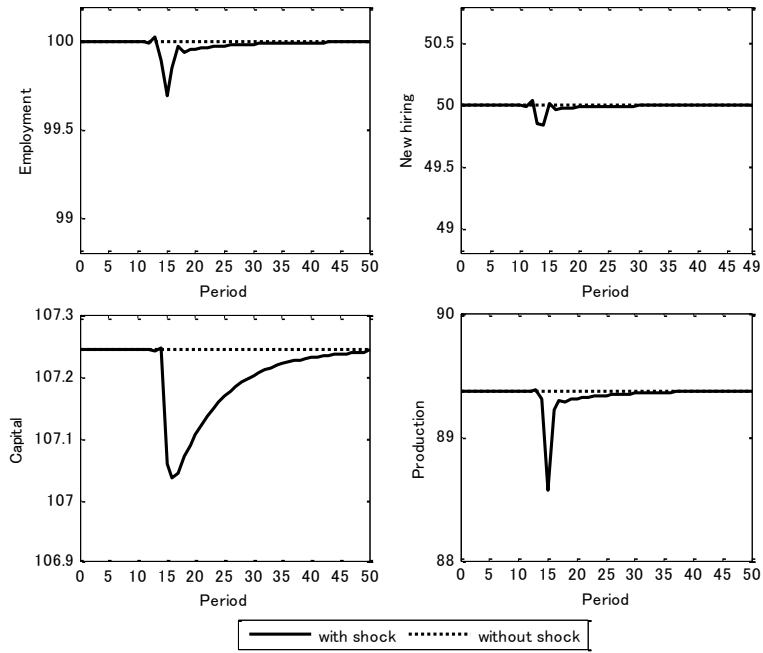


Fig. 2. FTC model with  $\tau = 0.01$  (temporary shock).

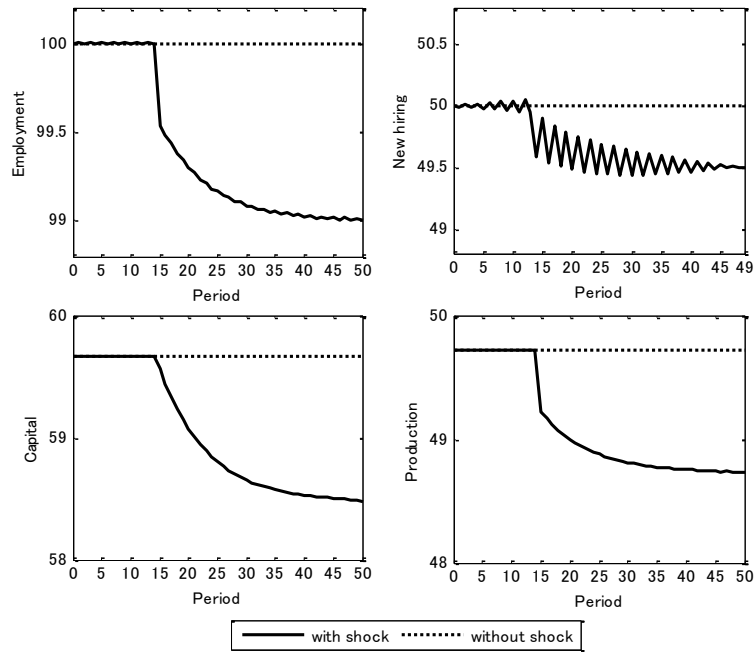


Fig. 3. FTC model with  $\tau = 0$  (permanent shock).

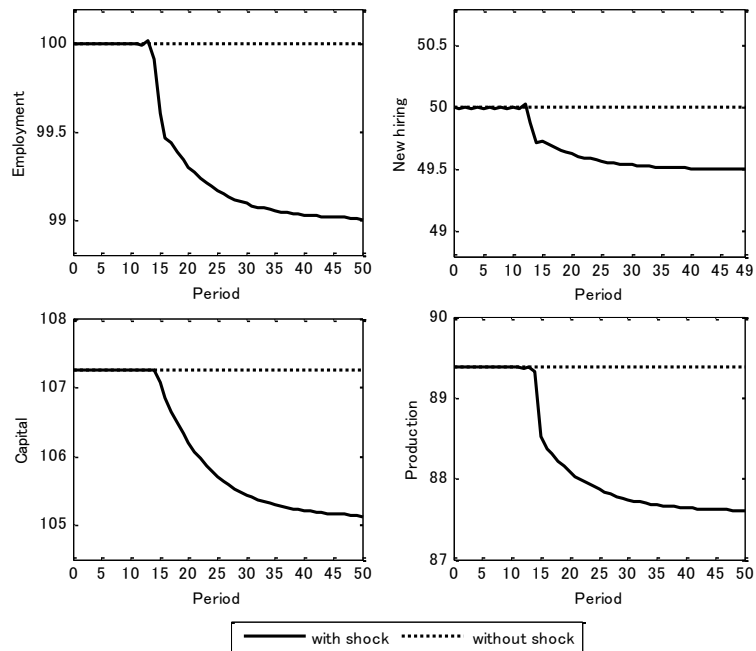


Fig. 4. FTC model with  $\tau = 0.01$  (permanent shock).

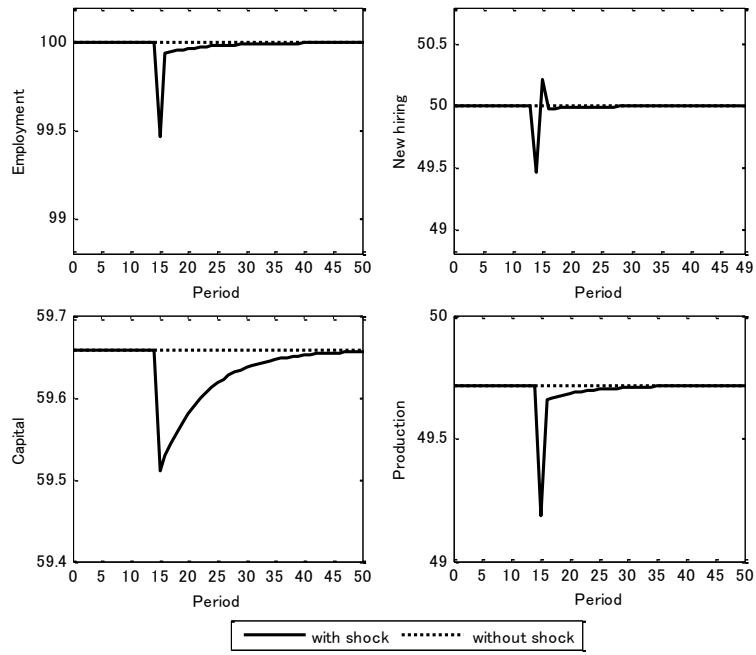


Fig. 5. ITC model with  $\tau = 0$  (temporary shock).

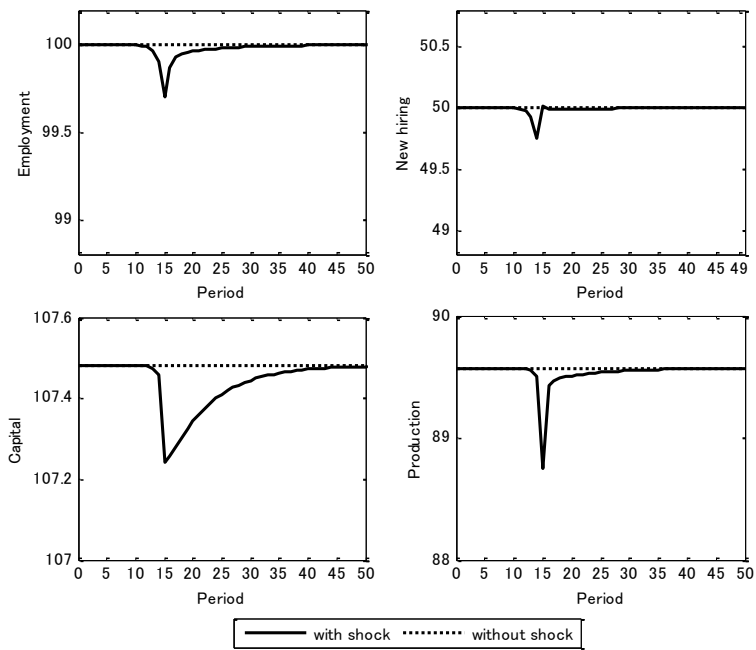


Fig. 6. ITC model with  $\tau = 0.01$  (temporary shock).

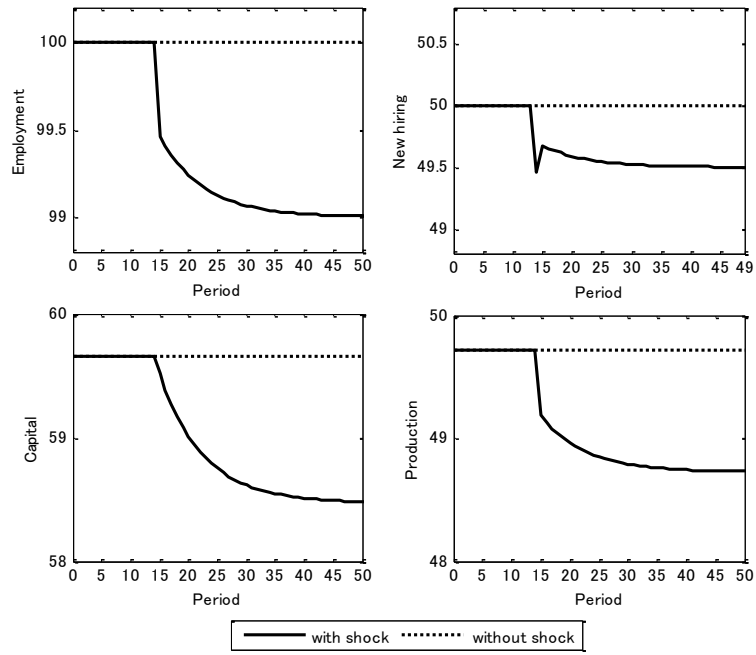


Fig. 7. ITC model with  $\tau = 0$  (permanent shock).

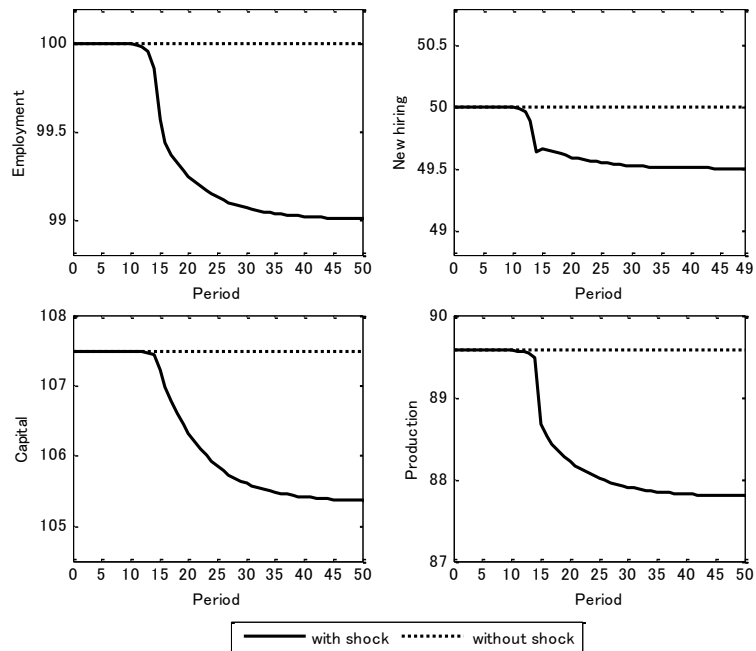


Fig. 8. ITC model with  $\tau = 0.01$  (permanent shock).

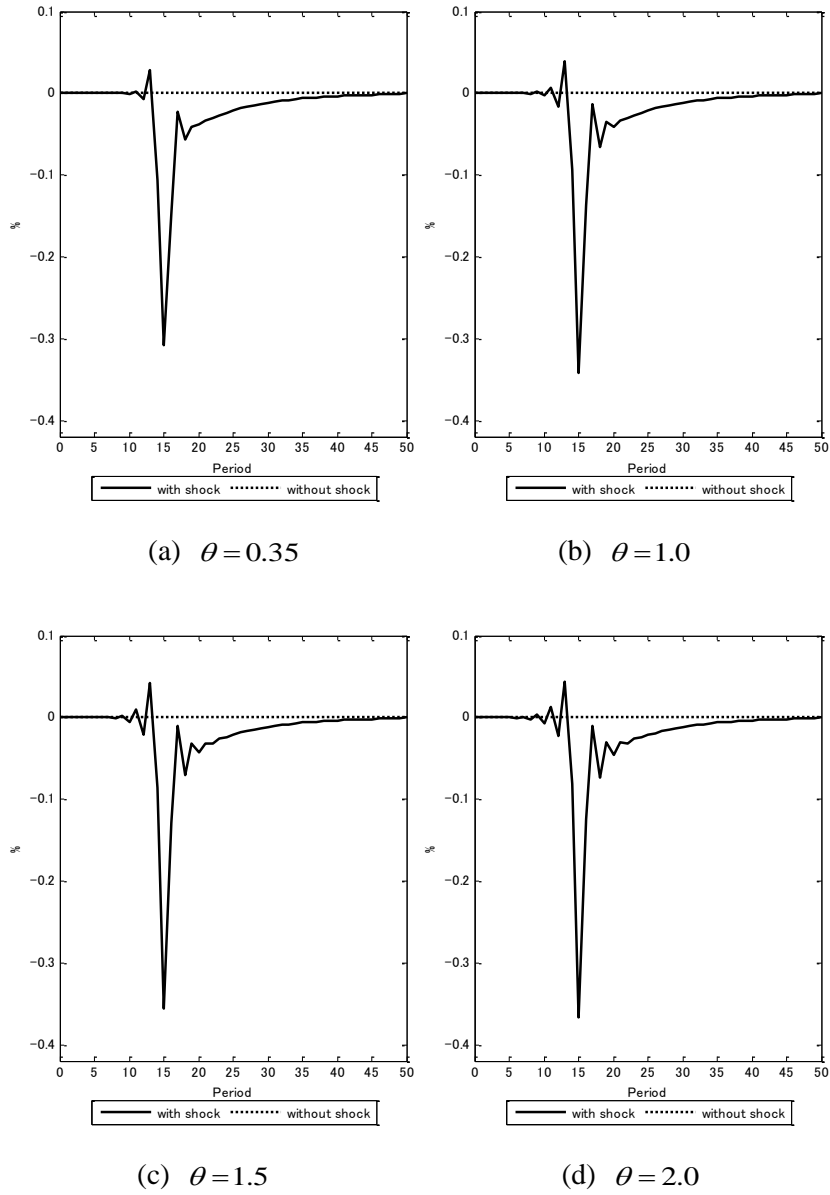
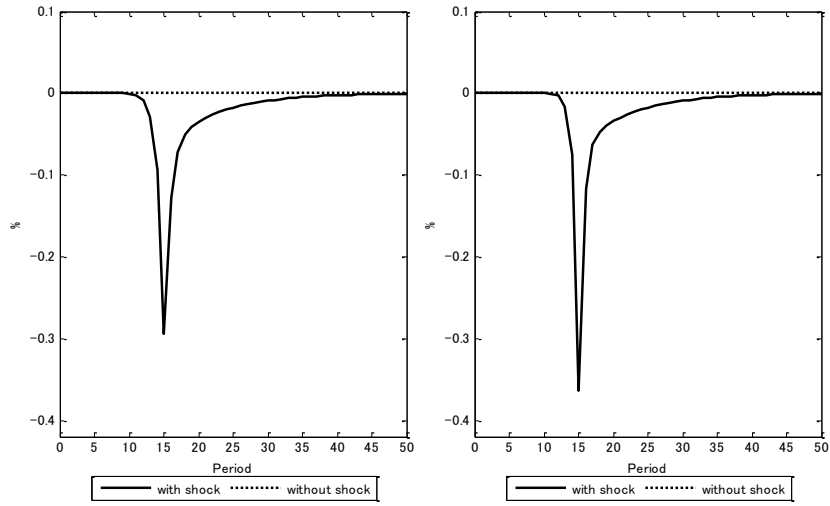
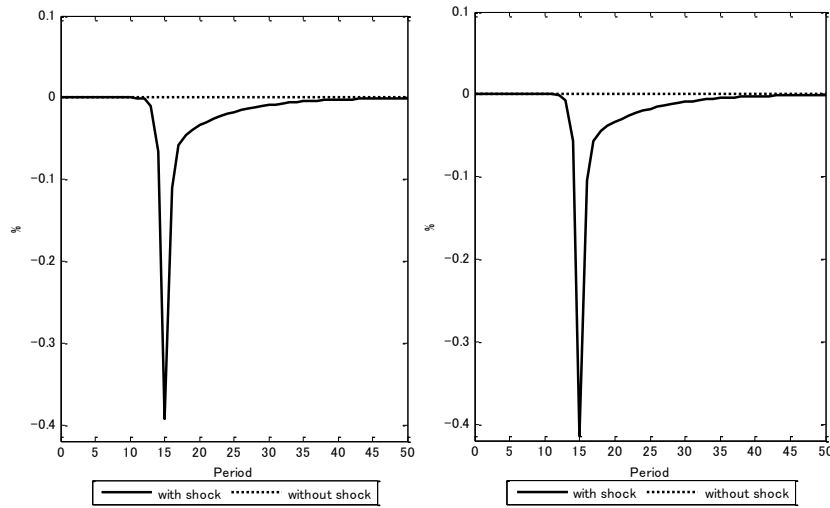


Fig. 9. Union influence and employment fluctuations (FTC model).



(a)  $\theta = 0.35$

(b)  $\theta = 1.0$



(c)  $\theta = 1.5$

(d)  $\theta = 2.0$

Fig. 10. Union influence and employment fluctuations (ITC model).

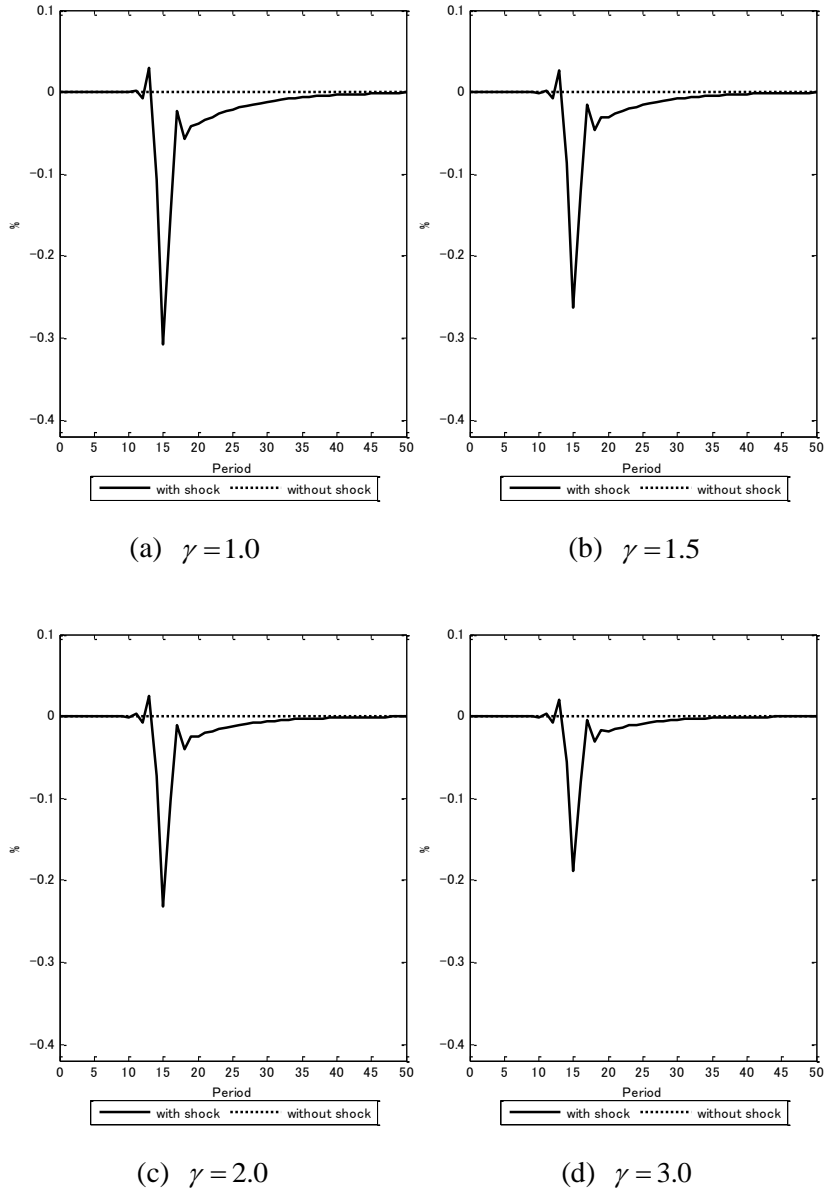
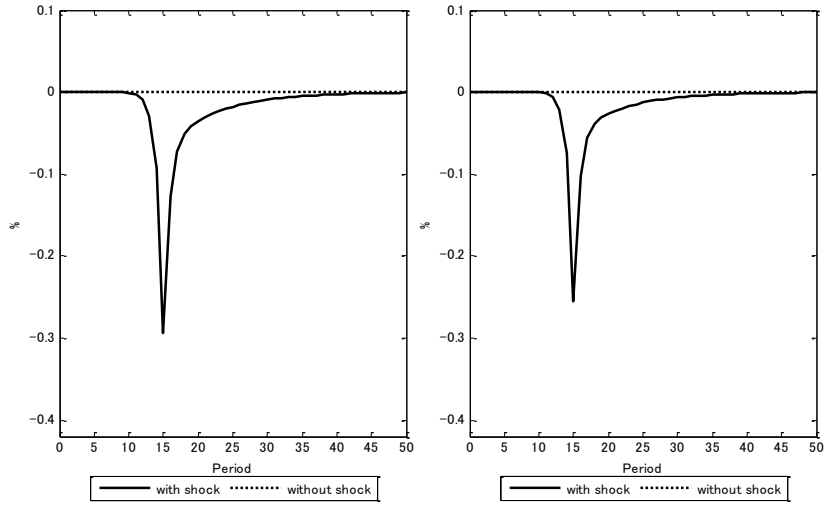
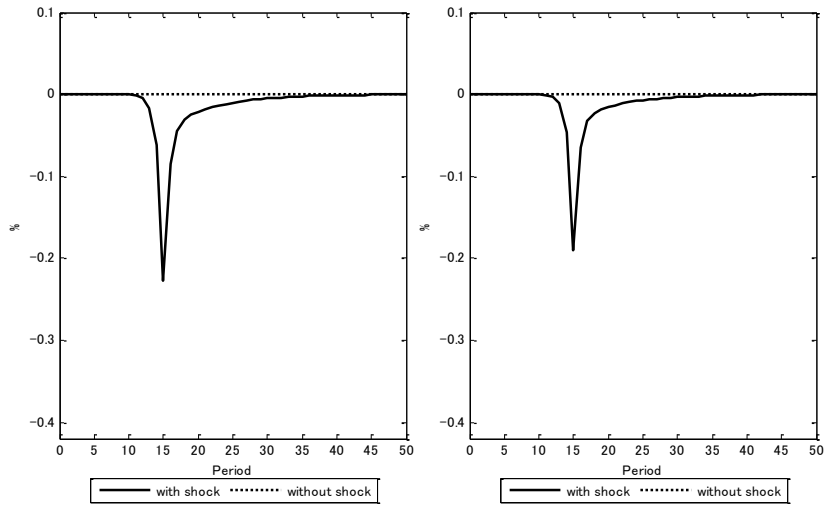


Fig. 11. Elasticity of wage with respect to employment rate and employment fluctuations (FTC model).



(a)  $\gamma = 1.0$

(b)  $\gamma = 1.5$



(c)  $\gamma = 2.0$

(d)  $\gamma = 3.0$

Fig. 12. Elasticity of wage with respect to employment rate and employment fluctuations (ITC model).