Employment fluctuations in a dynamic model with long-term and short-term contracts

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Abstract

Fluctuations in employment are one of the central issues in the labor market literature and have been investigated in a number of empirical and theoretical studies. This study presents a dynamic labor demand framework in which long-term and short-term contracts coexist, and analyzes the employment fluctuations to a temporary productivity shock. The differences between long-term and short-term contracts are stickiness of employment adjustments and explicit employment duration. This study shows that the fluctuations in short-term employment are more volatile than that of long-term employment. Moreover, it indicates that the large adjustment cost brings about the decreasing in employment fluctuations. The adjustment cost plays a role in smoothing the employment fluctuations, which is consistent with the result in a standard dynamic labor demand model. In addition, this study shows that the high quit rate leads to the high variations in long-term and short-term employment to the shock, and results in large employment fluctuations.

JEL classification: E24; J23; J32; J41; D90

Keywords: employment dynamics; dynamic labor demand; labor market institutions; adjustment cost; employment duration

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1. Introduction

Labor market institutions are reformed frequently, which affects employment dynamics. This study presents a dynamic labor demand model that can analyze the economy in which long-term and short-term contracts coexist and analyzes the employment fluctuations through numerical experiments. The short-term contracts such as fixed-term contracts (FTC) and temporary agency work are part of labor market institutions and they are adopted in many countries.[1] Portugal and Varejão (2009) point out that FTC are used for saving costs, screening for permanent positions, and temporary replacement. Givord and Wilner (2015) focus on the differences in short-term contracts in the context of the career prospects; using French data, they show that FTC are used as stepping stones to permanent positions. Nunziata and Staffolani (2007), using data from some European countries, also find the same role for FTC. Moreover, Faccini (2013) shows that the transitions of temporary workers to permanent positions are frequent in most European countries.

Some studies investigate the relationship between employment protection legislation (EPL) and temporary jobs. OECD (2017) points out that the strict employment protection for regular workers promotes using temporary contracts in OECD countries. Centeno and Novo (2012) analyze the effects of employment protection of open-ended contracts in the Portuguese labor market and indicate that stringent protection increases dependence on FTC. Hijzen et al. (2017) investigate the effects of employment protection on the composition of the labor force and turnover in Italy and show that temporary contracts are increased when firms face more stringent employment protection for permanent contracts. Moreover, Banker et al. (2013) point out that the strictness of EPL is a reliable proxy variable for labor adjustment costs. The results, based on the analysis of data from some OECD countries, show that the stricter EPL is related to higher stickiness.

The relationship between EPL and fluctuations in employment has also been studied. Gnocchi et al. (2015) examine the labor market reforms from the 1970s to the 2000s in some OECD countries and point out that the reforms relaxing EPL increase employment volatility. Faccini and Bondibene (2012) study the labor market institutions and cyclical behavior of the unemployment rate in OECD countries. Their findings indicate that the EPL for permanent workers reduces the

[1] Cahuc et al. (2016) explain the regulations about the temporary contracts in some OECD countries. The temporary employment incidence and composition in OECD countries are listed in OECD (2017), p.205. Also, the shares of temporary employment in total employment in European countries are listed in Eichhorst et al. (2017), page 4 of 17, and the share in the US is described in Yang (2018), p.412. The shares of temporary workers by industry and country in some European countries are shown in Damiani et al. (2016), p.596.

volatility of unemployment rates.

In a theoretical analysis of an economy in which long-term and short-term contracts coexist, the differences between the contracts are such as stickiness of employment adjustments, employment duration, and types of jobs and skills. Berton and Garibaldi (2012) assume that decreasing permanent employment depends on worker turnover, whereas the firm can fire the temporary employment at will. Blanchard and Landier (2002) suppose that firms hire workers in entry-level jobs, who are then retained in a regular job if they are not laid off. In Caggese and Cuñat (2008), Cahuc et al. (2016) and Cahuc and Postel-Vinay (2002), the permanent contracts do not have predetermined duration, firms pay a firing cost if they fire those in permanent employment, temporary contracts stipulate a fixed duration, and the firms do not incur firing costs at the end of the contracts. Smith (2007) supposes that the difference between permanent and temporary jobs is that the duration of permanent contract is infinite, whereas that of temporary contract is finite. Yang (2018) assumes that firms pay a fixed firing cost when they fire permanent employment.

This study also assumes the difference between long-term and short-term contracts focusing on stickiness of employment adjustments and employment duration, and analyzes the responses of employment to the temporary productivity shock. The duration of long-term contracts is two periods and the duration of short-term contracts is one period. The assumption about the long-term and short-term contracts is also discussed in Macho-Stadler et al. (2014). Moreover, Matsue (2018) focuses on the fixed employment duration and produces two types of dynamic labor demand models: One with FTC and the other with indefinite term contracts (ITC). It shows that an expected productivity shock causes the oscillatory behavior of employment in the FTC model, while it does not in the ITC model. This study shows that the same property in the FTC model is also observed in the model when long-term and short-term employment coexist.

In the numerical analysis, we investigate the effects of the adjustment cost for long-term employment on fluctuations in labor demand. We find that the responses of long-term new hiring, long-term employment, short-term employment and total employment are reduced when firms pay the large adjustment cost. The effects of the adjustment cost for long-term employment on fluctuations in total employment are in consistent with Faccini and Bondibene (2012). The adjustment cost plays a role in smoothing the employment fluctuations. Moreover, the fluctuations in short-term employment are more volatile than that of long-term employment, which is in line with Caggese and Cuñat (2008) and Yang (2018). Caggese and Cuñat (2008) indicate that the fluctuations in fixed-term employment are more volatile than that of permanent employment using Italian data. Yang (2018) shows that the high volatility of temporary employment is observed in the US labor market. In addition, the effects of the quit rate on employment fluctuations are analyzed. We find that the responses of long-term employment, short-term employment and total employment to the shock are large when the quit rate is high.

The rest of the study is organized as follows. Section 2 sets up a simple model and discusses its properties. Section 3 extends the model and investigates the effects of adjustment cost and quit rate on fluctuations in labor demand. Section 4 concludes the study.

2. Simple model

Consider a dynamic model that can analyze the economy in which long-term and short-term contracts coexist. A firm plans its production during the finite time period T. The inputs to production are long-term employment L_t^l and short-term employment L_t^s. The objective function of the firm takes the following form:

$$V = \sum_{t=0}^{T} \beta^t \left[F\left(L_t^l, L_t^s; A_t\right) - w^l L_t^l - w^s L_t^s\right],$$

where $0 < \beta < 1$ is a discount factor, $A_t > 0$ is the productivity parameter, $w^l > 0$ is the wage of a long-term contract, and $w^s > 0$ is the wage of a short-term contract. It is assumed that the firm enters into a long-term contract or a short-term contract with labor: The term of long-term contracts is two periods and the term of short-term contracts is one period. Then, the long-term employment at period t is sum of the long-term new hiring at period t and $t-1$, that is $L_t^l = h_t^l + h_{t-1}^l$. The short-term employment at period t is the short-term new hiring at period t, that is $L_t^s = h_t^s$. Also, h_{-1}^l, h_0^l, h_T^l and h_{T+1}^l are given, then L_0^l and L_{T+1}^l are given. The firm decides the number of newly hired workers $\left(h_1^l, h_2^l, \cdots, h_{T-1}^l\right)$ and $\left(h_0^s, h_1^s, \cdots, h_T^s\right)$ to maximize V. The same assumption of contract duration is discussed in Macho-Stadler et al. (2014). First-order conditions for long-term employment is as follows:

$$\sum_{i=t}^{t+1} \beta^i F_{L^l}\left(L_i^l, L_i^s; A_i\right) = \sum_{i=t}^{t+1} \beta^i w^l, t = 1,2,\cdots,T-1. \quad (1)$$

First-order conditions for short-term employment is as follows:

$$F_{L^s}\left(L_t^l, L_t^s; A_t\right) = w^s, t = 0,1,\cdots,T. \quad (2)$$

The left-hand sides of (1) and (2) express the marginal product of labor, and the right-hand sides of (1) and (2) express the marginal cost of labor. Short-term employment is chosen by a firm to maximize its current profit because there is no intertemporal element.

Suppose that the production function is a multiplicative form which satisfies $F_{L^l} > 0$, $F_{L^l L^l} < 0$, $F_{L^l L^s} > 0$, $F_{L^s} > 0$, $F_{L^s L^s} < 0$, $F_{L^s L^l} > 0$, $F_A > 0$, $F_{L^l A} > 0$ and $F_{L^s A} > 0$. Then,

(2) is transformed as follows:

$$L_t^s = G\left(L_t^l;\ A_t\right), t = 0,1,\cdots,T. \qquad (3)$$

Substituting (3) into (1), we have the following.

$$\sum_{i=t}^{t+1} \beta^i\, F_{L^l}\left(L_i^l; A_i\right) = \sum_{i=t}^{t+1} \beta^i\, w^l, t = 1,2,\cdots,T-1. \qquad (4)$$

From (3), (4) and $dL_t^l = dh_t^l + dh_{t-1}^l$, we obtain the comparative dynamics results.

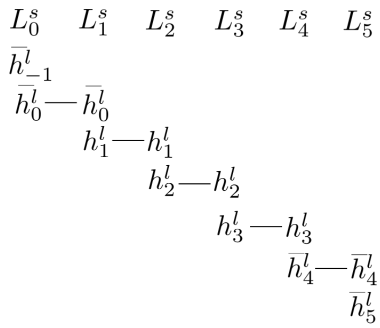

Fig. 1 The model with $T = 4$

Let us specify the planning period equals 5, that is, $T = 4$. The model structure is illustrated in Figure 1. In the periods at 0 and 5, the long-term new hiring is given: $\bar{h}_{-1}^l$, $\bar{h}_0^l$, $\bar{h}_4^l$, $\bar{h}_5^l$. In the period at 0, the long-term employment L_0^l is a sum of the long-term new hiring $\bar{h}_0^l$ and $\bar{h}_{-1}^l$, who are hired at periods 0 and -1, respectively. The short-term employment at period 0 is a short-term new hiring at period 0, that is $L_0^s = h_0^s$. Then, the total employment at period 0 is the sum of the long-term employment L_0^l and short-term employment L_0^s. Similarly, in the period at 1, the long-term employment L_1^l equals to sum of h_1^l and $\bar{h}_0^l$. The short-term employment at period 1 is $L_1^s = h_1^s$. Then, the total employment at period 1 equals the sum of L_1^l and L_1^s. The long-term, short-term and total employment in the other period are the same structure.

Table 1. The effects of the change in A_i on h_j^l

	h_1^l	h_2^l	h_3^l
A_1	+	−	+
A_2	+	+	−
A_3	−	+	+
A_4	+	−	+

Table 2. The effects of the change in A_i on L_j^l

	L_1^l	L_2^l	L_3^l	L_4^l
A_1	+	+	−	+
A_2	+	+	+	−
A_3	−	+	+	+
A_4	+	−	+	+

Table 3. The effects of the change in A_i on L_j^s

	L_1^s	L_2^s	L_3^s	L_4^s
A_1	+	+	−	+
A_2	+	+	+	−
A_3	−	+	+	+
A_4	+	−	+	+

Table 4. The effects of the change in A_i on $L_j^l + L_j^s$

	$L_1^l + L_1^s$	$L_2^l + L_2^s$	$L_3^l + L_3^s$	$L_4^l + L_4^s$
A_1	+	+	−	+
A_2	+	+	+	−
A_3	−	+	+	+
A_4	+	−	+	+

Suppose that an expected temporary positive productivity shock takes place; then the comparative dynamic results are as summarized in Tables 1–4. The sign in the tables express the effects of the change in A_i on h_j^l, L_j^l, L_j^s, $L_j^l + L_j^s$, that is $sign(dh_j^l/dA_i)$, $sign(dL_j^l/dA_i)$, $sign(dL_j^s/dA_i)$, and $sign(d(L_j^l + L_j^s)/dA_i)$. In the planning periods, the firm both increases and decreases each employment in spite of the positive productivity shock that takes place. If the positive productivity shock takes place at period 1, the firm increases h_1^l to increase L_1^l. Then, if the firm does not decrease h_2^l, the firm employs too much long-term employment at period 2, because $L_2^l = h_2^l + h_1^l$. Similarly, the firm increases h_3^l to avoid too little long-term employment at period 3. The short-term employment is also adjusted together with the change in long-term employment. These decisions lead to the oscillatory behavior of employment. The long-term and short-term employment face the same change. Matsue (2018) also indicates the oscillatory behavior of labor demand using a dynamic labor demand model. The input is only labor, and then the firm makes an agreement for a fixed-term contract with labor in the model. The same mechanism of labor adjustment is discussed in the paper. The results in this study indicate that the behavior is also observed in the model with long-term and short-term employment.

In the dynamic labor demand literature, adjustment cost models are widely used.[2] As pointed out by Matsue (2018), they do not show the oscillatory behavior. If the positive shock takes place at a period, the firm increases new hiring in order to adjust total employment at the period. Then, the firm does not decrease the employment during planning periods.

3. Numerical experiments

To consider the effects of change in adjustment cost and quit rate on employment dynamics, we extend the model in section 2.

3.1 Baseline model

It is assumed that the firm incurs an adjustment cost and the long-term employment quits at a constant rate at the end of the period in which he/she is hired. The adjustment cost includes, for example, advertising job positions, interviewing and training. The objective function of the firm takes the following form:

$$V = \sum_{t=0}^{T} \beta^t \left[F\left(L_t^l, L_t^s; A_t\right) - w^l L_t^l - w^s L_t^s - \frac{1}{2}\tau\left(h_t^l\right)^2\right],$$

where $\tau \geq 0$ is the adjustment cost of long-term new hiring. This type of adjustment cost function is also discussed in Cabo and Martín-Román (2019), Campbell and Orszag (1998), and Galí and van Rens (2010).[3] The long-term employment at period t is the sum of the long-term new hiring at period t and the long-term new hire at $t-1$ who does not quit, that is $L_t^l = h_t^l + (1-\delta)h_{t-1}^l$, where $0 < \delta < 1$ is the quit rate. The short-term employment at period t is short-term new hiring at period t, that is $L_t^s = h_t^s$. Also, h_{-1}^l, h_0^l, h_T^l and h_{T+1}^l are given, then L_0^l and L_{T+1}^l are given. The firm decides the number of newly hired workers $\left(h_1^l, h_2^l, \cdots, h_{T-1}^l\right)$ and $\left(L_0^s, L_1^s, \cdots, L_T^s\right)$ to maximize V. First-order conditions for long-term employment are as

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[2]Bentolila and Saint-Paul (1994) and Saint-Paul (1996) discuss dynamic labor demand models with adjustment costs. Cabo and Martín-Román (2019) explain the dynamic labor demand literature in detail. Hamermesh and Pfann (1996) expound the property of the adjustment cost model.

[3]Some studies using quadratic adjustment costs are listed in Appendix A.

follows:

$$\sum_{i=t}^{t+1} \beta^i F_{L^l}(L_i^l, L_i^s; A_i) = \beta^t(w^l + \tau h_t^l) + \beta^{t+1}(1-\delta)w^l, t = 1,2,\cdots,T-1. \quad (5)$$

First-order conditions for short-term employment are as follows:

$$F_{L^s}(L_t^l, L_t^s; A_t) = w^s, t = 0,1,\cdots,T. \quad (6)$$

In the numerical analysis, we suppose that the production function is $F(L_t^l, L_t^s; A_t) = A_t(L_t^l)^\alpha (L_t^s)^\gamma$, $\alpha > 0$, $\gamma > 0$ and $0 < \alpha + \gamma < 1$. Then, (5) is as follows.

$$\sum_{i=t}^{t+1} \beta^i \alpha (1-\delta)^{i-t} A_i \left[h_i^l + (1-\delta)h_{i-1}^l\right]^{\alpha-1} (L_i^s)^\gamma$$
$$= \beta^t(w^l + \tau h_t^l) + \beta^{t+1}(1-\delta)w^l, t = 1,2,\cdots,T-1, \quad (7)$$

where $L_t^l = h_t^l + (1-\delta)h_{t-1}^l$. Similarly, (6) is as follows.

$$\gamma A_t\left[h_t^l + (1-\delta)h_{t-1}^l\right]^\alpha (L_t^s)^{\gamma-1} = w^s, t = 0,1,\cdots,T. \quad (8)$$

We consider the case of $T = 10$. The discount factor β set to 0.96. The adjustment cost parameter τ is 0.1 and the quit rate δ is 0.15, which are the same values used in Cabo and Martín-Román (2019).[4] The parameters α and γ are set to 0.4. The wage rates w^l and w^s are set to 0.5. The initial productivity level A is 1.0. It is supposed that h_{-1}^l, h_0^l, h_{10}^l and h_{11}^l are set to the steady-state value of long-term new hiring, and L_0^l and L_{11}^l are the steady-state value of long-term employment.[5] The steady-state value of short-term employment ratio $L^s/(L^l + L^s)$ is 0.5046.

Suppose that the temporary productivity shock takes place at period 1: The productivity increases one percent at period 1 and then returns at period 2. The results of baseline simulation are represented in Figure 2. The short-term employment is more volatile than long-term employment, which is in line with Caggese and Cuñat (2008) and Yang (2018). Caggese and Cuñat (2008) indicate that the fluctuations in fixed-term employment are more volatile than that of permanent employment using Italian data. Yang (2018) shows that the high volatility of temporary employment is observed in the US labor market.

If it is assumed that all of the long-term employment quit at the end of the first period in which they are hired ($\delta = 1$), no adjustment cost ($\tau = 0$) and no wage differences ($w^l = w^s$), and parameters in production function are the same ($\alpha = \gamma$), then the difference between long-term

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[4]See Cabo and Martín-Román (2019), p.122, footnote 26. Blatter et al. (2012) show a histogram of average hiring costs to fill a vacancy using Swiss administrative firm-level survey data (p.26). Booth and Francesconi (2000) indicate that 8.88% of men and 9.47% of women in full-time employment voluntarily quit their jobs each year in Britain (p.178, 180). Fairise and Fève (2006) suppose that the quit rate equals to 0.015, which roughly matches the average destruction rate in the US manufacturing sector from 1972 to 1993 (p.101). Silva and Toledo (2009) analyze the US labor market and assume an exogenous separation probability is 0.065 in the simulation (p.85). Goux et al. (2001) show that the voluntary quit rate is about 4% of the work force each year, which use French data (p.547).

[5]The steady-state value $h_{-1}^l = h_0^l = h_{10}^l = h_{11}^l = h^l$, $L_0^l = L_{11}^l = L^l$ and L^s are shown in Appendix B.

and short-term employment does not exist. Then, the firm adjusts the employment only in the shock period, and the response of long-term employment equals that of short-term employment.

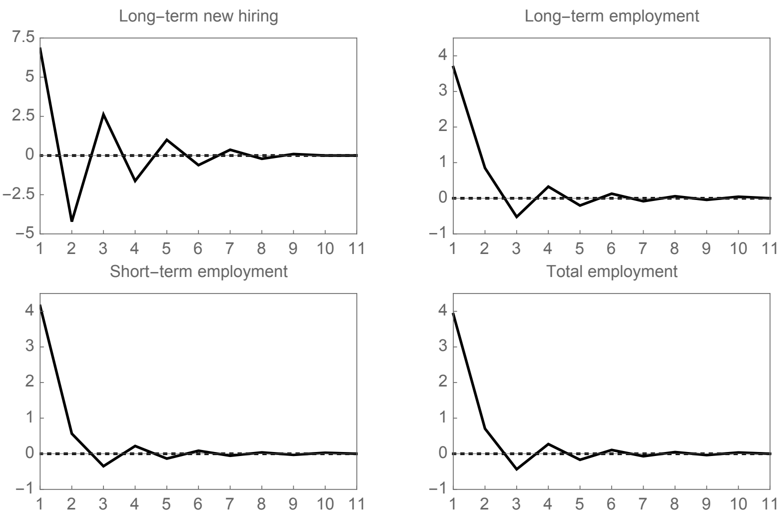

Fig. 2 Employment response in baseline simulations

Notes: The solid line shows the percentage deviation of the variables from their steady-state values, when the temporary productivity shock takes place. The dotted line represents the case without the shock.

3.2 Adjustment cost and fluctuations in labor demand

In this section, we present an analysis of the effects of adjustment cost on employment dynamics. The same parameters are used in the baseline simulation except for the adjustment cost $\tau = 0.3$. It is also assumed that the temporary productivity shock takes place at period 1, which is a one percent increase in productivity.

The short-term employment ratio in the steady-state is 0.5123, which is larger than the baseline case. The large adjustment cost brings the high short-term employment ratio in the model. The result is supported by literature on labor market institutions. The strictness of employment protection legislation (EPL) is one of the proxy variables for labor adjustment costs. Centeno and Novo (2012) indicate that stringent protection increases dependence on FTC. Hijzen et al. (2017) point out that temporary contracts are increased when the employment protection for permanent contracts is strict. OECD (2017) shows that the strict employment protection for regular workers promotes using temporary contracts.

The results of numerical experiments are represented in Figure 3. The responses of all variables are smaller than that of the baseline simulations. The adjustment cost plays a role in smoothing the employment fluctuations, which is the same result found in the literature on dynamic labor demand (e.g., Nickell 1986). Moreover, the simulation results could be supported by Faccini and Bondibene (2012), which indicate that the EPL for permanent workers reduces the volatility of unemployment rates.

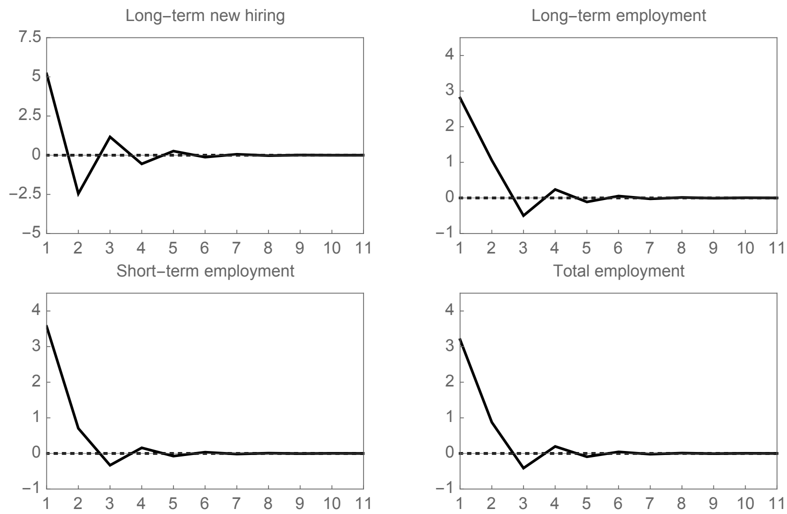

Fig. 3 Employment response with large adjustment cost

Notes: The solid line shows the percentage deviation of the variables from their steady-state values, when the temporary productivity shock takes place. The dotted line represents the case without the shock.

3.3 Quit rate and fluctuations in labor demand

Let us analyze the relationship between quit rate and employment fluctuations. The same parameters are used in the baseline simulations except for the quit rate $\delta = 0.45$. It is also supposed that the temporary productivity shock takes place at period 1, which is a one percent increase in productivity.

The short-term employment ratio in the steady-state is 0.5063, and which is larger than the baseline case. The results of numerical experiments are described in Figure 4. The responses of long-term employment, short-term employment and total employment are larger than that of the baseline simulations, whereas the response of long-term new hiring is smaller. The firm increases the long-term and short-term employment greatly. Thus, the higher volatility of total employment is obtained when the quit rate is high.

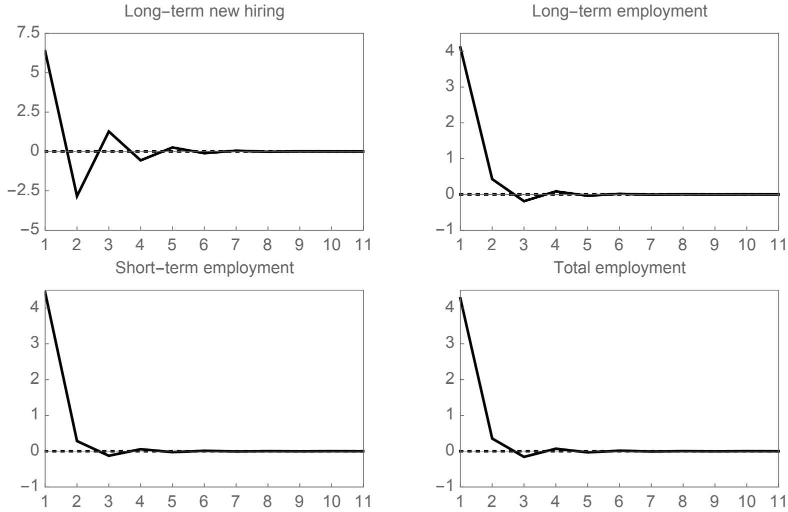

Fig. 4 Employment response with higher quit rate

Notes: The solid line shows the percentage deviation of the variables from their steady-state values, when the temporary productivity shock takes place. The dotted line represents the case without the shock.

4. Concluding remarks

The relationship between the composition of the labor force and employment dynamics has been investigated in a number of studies. This study presents a framework that can analyze an economy in which long-term and short-term contracts coexist. We investigate the effects of adjustment cost and quit rate on fluctuations in labor demand through numerical experiments. The model shows that the response of employment to the temporary productivity shock is reduced when the adjustment cost is large. Moreover, the high quit rate brings about the large employment fluctuations.

The model in this study is restricted to a simple case in which the term of long-term contracts is only two periods. It should be analyzed further using a more general case. In this study, we focus on the labor demand side. The model can be extended to consider the supply side of labor. Additional study of these issues should be undertaken in future research.

Appendix A. Quadratic adjustment costs

Table A1. Quadratic labor adjustment costs

Literatures	Variables
Akinci and Chahrour (2018)	Growth rate of working hours.
Belo et al. (2014)	Output, firing, hiring and employment level.
Bloom (2009)	Firing, hiring and employment level.
Cabo and Martín-Román (2019)	Firing, hiring and wage.
Campbell and Orszag (1998)	Firing and hiring.
Cooper and Willis (2009)	Employment growth and employment level.
Fairise and Fève (2006)	Hiring, turnover and employment level.
Galí and van Rens (2010)	Firing and hiring.
Hall (2004)	Employment growth, employment level and wage/product price.
Ju et al. (2014)	Difference between employment level and steady state level of employment.
Lapatinas (2009)	Employment growth and employment level.
Vogel (2017)	Wage and change in employment level.

The adjustment costs include, for example, advertising job positions, interviewing, training, disruption of production cost, and severance pay. They are expressed as an adjustment cost function in theoretical and empirical models. In the literature, a quadratic adjustment cost function is frequently assumed. Then, the adjustment costs depend on some variables, as shown in Table A1. Variables in the table demonstrate that the adjustment costs depend upon which variables are used in each study. The adjustment cost functions are formulated in various forms. Lapatinas (2009) also discusses the other adjustment cost models: Quadratic adjustment costs and disruption of production costs model, quadratic adjustment costs and fixed costs model, and quadratic adjustment costs, fixed costs and disruption of production costs model.

Appendix B. Steady-state values in numerical experiments

To consider the steady-state value of long-term employment, we assume that $h_{t+1}^l = h_t^l = h^l$, $L^l = (2-\delta)h^l$, $L_t^s = L^s$ and $A_{t+1} = A_t = A$ in (7). Then, the following equation is obtained.

$$L^l = \left(\frac{[1+\beta(1-\delta)]\alpha(2-\delta)A(L^s)^\gamma}{[1+\beta(1-\delta)](2-\delta)w^l+\tau L^l}\right)^{\frac{1}{1-\alpha}} \qquad \text{(A1)}$$

From $L^l = (2-\delta)h^l$, (A1) is transformed as follows.

$$h^l = \left(\frac{[1+\beta(1-\delta)]\alpha(2-\delta)A(L^s)^\gamma}{[1+\beta(1-\delta)](2-\delta)w^l+\tau L^l}\right)^{\frac{1}{1-\alpha}}\frac{1}{2-\delta}, \quad \text{(A2)}$$

which is the steady-state value of long-term new hiring. It is supposed that $h_{t+1}^l = h_t^l = h^l$, $L^l = (2-\delta)h^l$, $L_t^s = L^s$ and $A_t = A$ in (8). Then, we can transform the equation as follows.

$$L^s = \left(\frac{\gamma A}{w^s}\right)^{\frac{1}{1-\gamma}}(L^l)^{\frac{\alpha}{1-\gamma}}, \quad \text{(A3)}$$

which is the steady-state value of short-term employment. From (A1)–(A3), we obtain the steady-state value of h^l, L^l and L^s in the numerical experiments.

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