The impact of short-term employment contracts on employment volatility and economic fluctuations

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Abstract

This study investigates the effects of short-term employment contracts on employment fluctuations and economic fluctuations using a dynamic model with long-term and short-term employment contracts. Numerical experiments show that an increase in the short-term employment ratio amplifies the fluctuations in total employment—when an expected temporary productivity shock occurs—because of the variations in short-term employment being larger than those in long-term employment. Moreover, the large fluctuations in employment lead to the high variations in production and consumption. Promoting the utilization of short-term employment contracts would elicit the amplification of not only the employment fluctuations but also the economic fluctuations.

JEL classification: E24, E27, E32, J20, J41

Keywords: employment fluctuations, short-term employment, labor contract, employment duration, labor market institutions

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1. Introduction

Fluctuations in employment have been investigated in various fields and contexts, including labor market institutions. In labor market analysis, some empirical studies examine the relationship between the employment volatility and short-term employment contracts such as fixed-term contracts and temporary agency work. de Serres and Murtin (2013), using data of OECD countries, indicate that the large fluctuations in unemployment are caused by an increase in the share of temporary workers. OECD (2017) indicates that the response of unemployment rates to aggregate demand shocks is augmented under a high incidence of temporary work. This study investigates the effects of short-term employment contracts on employment volatility and economic fluctuations using numerical experiments.

In theoretical analysis with heterogeneous labor contracts, some differences between contracts are, for example, stickiness of employment adjustments, employment duration, and types of jobs and skills. Caggese and Cuñat (2008), Cahuc et al. (2016) and Cahuc and Postel-Vinay (2002) assume a permanent contract and a temporary contract in their analyses; the permanent contract has an indefinite duration and an adjustment cost associated with firing, while the temporary contract has a fixed duration and no adjustment costs. Smith (2007) classifies permanent and temporary jobs according to whether a contract period exists. Macho-Stadler et al. (2014) analyze the firms' optimization of long-term and short-term employment contracts; the long-term contract lasts for two periods (junior and senior) and the short-term contract for one period (junior or senior). In the dynamic labor demand literature, Matsue (2019) creates a model with a long-term and a short-term employment contract, which supposes that both contracts have a predetermined duration; firms incur adjustment costs only for hiring long-term employees, but no costs are incurred for hiring short-term employees.[1] It shows that an increase in the short-term employment ratio leads to an increase in employment fluctuations because of the high variations in short-term employment that are caused by the assumption of adjustment costs for hiring.

This study provides a dynamic framework with a long-term and a short-term employment contract. The differences between the contracts are the duration of employment periods and the wage determination. The analysis incorporates not only decisions on the demand side of labor but also on the supply side of labor, whereas Matsue (2019) provides the dynamic labor demand model. Numerical experiments indicate that the fluctuations in short-term employment are larger than those of long-term employment when an expected productivity shock takes place. These results can be explained by the

[1] The model with a fixed duration of employment is also discussed in Matsue (2018), which shows the properties of employment fluctuations under a fixed-term contract compared to the case with a permanent contract.

assumption of short-term contracts that stipulates the same wage level until the date of termination. Therefore, an increase in the short-term employment ratio brings about an increase in the variations of total employment, which is consistent with de Serres and Murtin (2013) and OECD (2017). Moreover, the model shows that large employment fluctuations cause large variations in production and consumption.

The remainder of this paper is organized as follows. Section 2 presents the dynamic model with long-term and short-term contracts. Section 3 provides the numerical experiments of the model. Section 4 concludes the paper.

2. Model

Suppose that the economy consists of firms and households. The firms combine long-term employment L_t^l and short-term employment L_t^s to produce Y_t, according to a Cobb-Douglas production function $Y_t = A_t\left(L_t^l\right)^{\alpha}(L_t^s)^{1-\alpha}$, where $0 < \alpha < 1$ and $A_t > 0$ is an exogenous productivity parameter. Suppose that the duration of the long-term contract is four periods and that of the short-term contract is two periods. Then, the long-term employment in period t is the sum of the long-term new hiring h_i^l in the periods t, $t-1$, $t-2$, and $t-3$, who do not quit:

$$L_t^l = h_t^l + (1-\delta)h_{t-1}^l + (1-\delta)^2 h_{t-2}^l + (1-\delta)^3 h_{t-3}^l, \tag{1}$$

where $0 \le \delta \le 1$ is the voluntary quit rate of the long-term contract. The short-term employment in period t is the sum of the short-term new hiring h_i^s in the periods t and $t-1$, who do not quit:

$$L_t^s = h_t^s + (1-\sigma)h_{t-1}^s, \tag{2}$$

where $0 \le \sigma \le 1$ is the voluntary quit rate of the short-term contract. It is assumed that the short-term wage is fixed during the contract period. Cahuc et al. (2016) also assume that firms pay workers a fixed wage prescribed in the contract for its duration. If all the long-term and short-term employees quit at the end of the first period in which they are hired ($\delta = \sigma = 1$), then no difference exists between the two types of contracts.

The objective function of the firm is as follows:

$$V = \sum_{t=0}^{T} \beta^t \left[A_t\left(L_t^l\right)^{\alpha}(L_t^s)^{1-\alpha} - w_t^l L_t^l - w_t^s h_t^s - w_{t-1}^s(1-\sigma)h_{t-1}^s\right],$$

where w_t^l is the wage under the long-term contract and w_t^s is the wage under the short-term contract. The firm chooses h_t^l and h_t^s to maximize V subject to (1) and (2), where h_{-3}^l, h_{-2}^l, h_{-1}^l, h_0^l, h_{T-2}^l, h_{T-1}^l, h_T^l, and h_{T+1}^l are given, that is, L_0^l and L_{T+1}^l are given; h_{-1}^s, h_0^s, h_T^s, and h_{T+1}^s are given, that is, L_0^s and L_{T+1}^s are given. The first-order conditions for long-term employment are as follows:

$$\sum_{i=t}^{t+3} \beta^i (1-\delta)^{i-t} \alpha A_i \left[\frac{h_i^l+(1-\delta)h_{i-1}^l+(1-\delta)^2 h_{i-2}^l+(1-\delta)^3 h_{i-3}^l}{h_i^s+(1-\sigma)h_{i-1}^s}\right]^{\alpha-1}$$

$$= \sum_{i=t}^{t+3} \beta^i (1-\delta)^{i-t} w_i^l, t = 1, 2, \cdots, T-3. \quad (3)$$

Meanwhile, the first-order conditions for short-term employment are as follows:

$$\sum_{i=t}^{t+1} \beta^i (1-\sigma)^{i-t} (1-\alpha) A_i \left[\frac{h_i^l+(1-\delta)h_{i-1}^l+(1-\delta)^2 h_{i-2}^l+(1-\delta)^3 h_{i-3}^l}{h_i^s+(1-\sigma)h_{i-1}^s}\right]^{\alpha}$$

$$= \sum_{i=t}^{t+1} \beta^i (1-\sigma)^{i-t} w_t^s, t = 1, 2, \cdots, T-1. \quad (4)$$

(3) and (4) indicate that the marginal product of labor equals to the marginal cost of labor.

The households have the following preference:

$$U = \sum_{t=0}^{T} \beta^t \left[logC_t - a\frac{(L_t^l)^{1+\gamma}}{1+\gamma} - b\frac{\{h_t^s+(1-\sigma)h_{t-1}^s\}^{1+\mu}}{1+\mu}\right],$$

where $0 < \beta < 1$ is the discount factor, $\gamma > 0$ and $\mu > 0$ are the labor supply parameters, $a > 0$ and $b > 0$ are the scaling factors, C_t is the consumption. A similar type of utility function is assumed, for example, in Galí et al. (2007) and Garín et al. (2019). The budget constraint is as follows:

$$C_t = w_t^l L_t^l + w_t^s h_t^s + w_{t-1}^s (1-\sigma) h_{t-1}^s$$

The households choose C_t, L_t^l, and h_t^s to maximize U subject to the budget constraint, where h_{-3}^l, h_{-2}^l, h_{-1}^l, h_0^l, h_{T-2}^l, h_{T-1}^l, h_T^l, and h_{T+1}^l are given, that is, L_0^l and L_{T+1}^l are given; h_{-1}^s, h_0^s, h_T^s, and h_{T+1}^s are given, that is, L_0^s and L_{T+1}^s are given. From the optimization problem, the following labor supply equations are obtained:

$$a(L_t^l)^{\gamma} = \frac{w_t^l}{C_t}, t = 1, 2, \cdots, T. \quad (5)$$

$$\sum_{i=t}^{t+1} \beta^i (1-\sigma)^{i-t} b[h_i^s + (1-\sigma)h_{i-1}^s]^{\mu}$$

$$= \sum_{i=t}^{t+1} \beta^i (1-\sigma)^{i-t} \frac{w_t^s}{C_i}, t = 1, 2, \cdots, T-1. \quad (6)$$

The goods market clearing condition is given by the following:

$$Y_t = C_t, t = 1, 2, \cdots, T. \quad (7)$$

From (1)–(7) and the production function, $(w_1^l, w_2^l, \cdots, w_T^l)$, $(w_1^s, w_2^s, \cdots, w_{T-1}^s)$, $(h_1^l, h_2^l, \cdots, h_{T-3}^l)$, $(L_1^l, L_2^l, \cdots, L_T^l)$, $(h_1^s, h_2^s, \cdots, h_{T-1}^s)$, $(L_1^s, L_2^s, \cdots, L_T^s)$, $(Y_1, Y_2, \cdots, Y_T)$, and $(C_1, C_2, \cdots, C_T)$ are determined. Suppose that the labor supply parameters are equal, that is, $\gamma = \mu$, in (5) and (6). Then, the steady-state values w^l, w^s, h^l, L^l, h^s, L^s, Y, and C are determined by (1)–(7) and the production function as follows:[2]

[2] The derivations of the steady-state values (8)–(15) are shown in the appendix.

$$w^l = \alpha A \left[\frac{\alpha b}{(1-\alpha)a}\right]^{\frac{\alpha-1}{1+\gamma}} \tag{8}$$

$$w^s = (1-\alpha) A \left[\frac{\alpha b}{(1-\alpha)a}\right]^{\frac{\alpha}{1+\gamma}} \tag{9}$$

$$h^l = \frac{1}{4-6\delta+4\delta^2-\delta^3}\left(\frac{\alpha}{a}\right)^{\frac{1}{1+\gamma}} \tag{10}$$

$$L^l = \left(\frac{\alpha}{a}\right)^{\frac{1}{1+\gamma}} \tag{11}$$

$$h^s = \frac{1}{2-\sigma}\left(\frac{1-\alpha}{b}\right)^{\frac{1}{1+\gamma}} \tag{12}$$

$$L^s = \left(\frac{1-\alpha}{b}\right)^{\frac{1}{1+\gamma}} \tag{13}$$

$$Y = A\left(\frac{\alpha}{a}\right)^{\frac{\alpha}{1+\gamma}}\left(\frac{1-\alpha}{b}\right)^{\frac{1-\alpha}{1+\gamma}} \tag{14}$$

$$C = A\left(\frac{\alpha}{a}\right)^{\frac{\alpha}{1+\gamma}}\left(\frac{1-\alpha}{b}\right)^{\frac{1-\alpha}{1+\gamma}} \tag{15}$$

3. Numerical experiments

In this section, the effects of changes in the short-term employment ratio on employment fluctuations and economic fluctuations are explored through numerical analysis.

3.1. Parameters setting

The parameter values corresponding to each short-term employment ratio are listed in Table 1. The scaling factor a in the utility function is set to 1.0. The discount factor β is set at 0.96. The labor supply parameters γ and μ are the same as the values used in Ateşağaoğlu and Torul (2018). The quit rate δ and σ are the same as the values used in Cabo and Martín-Román (2019).

The scaling factor in the utility function b and the parameter in the production function α are set to generate a steady-state wage ratio of short-term employment to long-term employment $\phi = w^s/w^l$ equals to 0.7 and a steady-state short-term employment ratio $\theta = L^s/(L^l + L^s)$ equals to 0.1, 0.2, 0.3, 0.4, and 0.5 (10%, 20%, 30%, 40%, and 50%). The setting of the wage ratio is based on OECD (2015), which points out that temporary workers' hourly wages are equal to about 70% of permanent workers' median hourly wages in some OECD countries. Substituting (8) and (9) into $\phi =$

w^s/w^l, we obtain the following:

$$b = a\phi^{1+\gamma}\left(\frac{\alpha}{1-\alpha}\right)^{\gamma} \tag{16}$$

The short-term employment ratio $\theta = L^s/(L^l + L^s)$ is transformed into $L^l/L^s = 1/\theta - 1$. By substituting (11) and (13) into $L^l/L^s = 1/\theta - 1$, the following equation is obtained:

$$\alpha = \frac{1}{1+\frac{b}{a}\left(\frac{\theta}{1-\theta}\right)^{1+\gamma}} \tag{17}$$

From (16) and (17), the parameters b and α are determined when the other parameters are given.

Table 1. Short-term employment ratio and parameter values

Short-term employment ratio		10%	20%	30%	40%	50%
a	Parameter in utility function	1.0	1.0	1.0	1.0	1.0
b	Parameter in utility function	13.1045	4.44472	2.16638	1.20195	0.7
α	Parameter in production function	0.927835	0.851064	0.769231	0.681818	0.588235
β	Discount factor	0.96	0.96	0.96	0.96	0.96
γ	Long-term labor supply parameter	4/3	4/3	4/3	4/3	4/3
μ	Short-term labor supply parameter	4/3	4/3	4/3	4/3	4/3
δ	Voluntary quit rate in long-term contracts	0.15	0.15	0.15	0.15	0.15
σ	Voluntary quit rate in short-term contracts	0.15	0.15	0.15	0.15	0.15

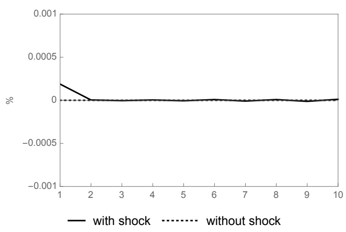
3.2. Effects of an increase in the short-term employment ratio

Consider the effects of an increase in the short-term employment ratio on employment volatility and economic fluctuations. It is assumed that planning period $T = 10$. The economy is in a steady-state at the beginning of the planning period and in the period $T + 1$: $h^l_{-3} = h^l_{-2} = h^l_{-1} = h^l_0 = h^l_8 = h^l_9 = h^l_{10} = h^l_{11} = h^l$, that is, $L^l_0 = L^l_{11} = L^l$; $h^s_{-1} = h^s_0 = h^s_{10} = h^s_{11} = h^s$, that is, $L^s_0 = L^s_{11} = L^s$. The productivity parameter in the steady-state is set at 1.0.

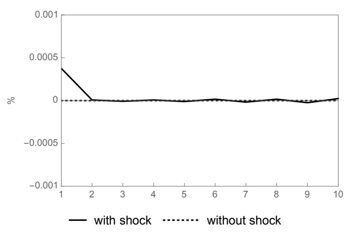
The steady-state values corresponding to each short-term employment ratio are shown in Table 2. The increase in the steady-state short-term employment ratio is brought about by a decrease in long-term employment and an increase in short-term employment. Total employment is defined as the sum of long-term employment and short-term employment $L^l_t + L^s_t$.

Table 2. Short-term employment ratio and steady-state values

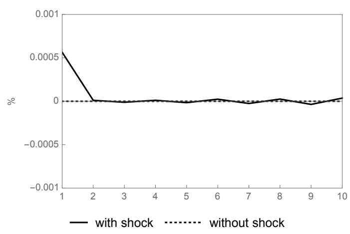
Short-term employment ratio	10%	20%	30%	40%	50%
Long-term new hiring	0.303898	0.292855	0.280438	0.266308	0.24998
Long-term employment	0.968409	0.933219	0.893649	0.848624	0.796592
Short-term new hiring	0.0581627	0.126111	0.207023	0.30581	0.430591
Short-term employment	0.107601	0.233305	0.382993	0.565749	0.796592
Total employment	1.07601	1.16652	1.27664	1.41437	1.59318
Long-term employment wage	0.791786	0.692299	0.632614	0.599293	0.588235
Short-term new hiring wage	0.55425	0.484609	0.44283	0.419505	0.411765
Production	0.826411	0.759128	0.734936	0.745909	0.796592
Consumption	0.826411	0.759128	0.734936	0.745909	0.796592



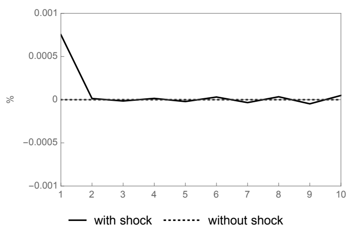
(a) $\theta = 0.1$



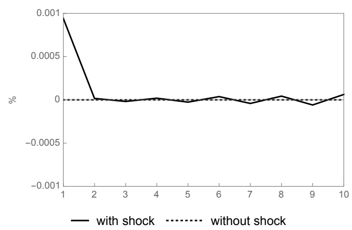
(b) $\theta = 0.2$



(c) $\theta = 0.3$



(d) $\theta = 0.4$



(e) $\theta = 0.5$

Fig. 1 Short-term employment ratio and fluctuations in total employment

It is assumed that an expected temporary productivity shock takes place in period 1: Productivity increases one percent in period 1 and then returns to the initial level in period 2. The initial productivity level is the same as the value in the steady-state productivity, which is set to 1.0. The results of numerical experiments are shown in Fig. 1 and Table 3.

The relationship between the short-term employment ratio and the fluctuations in total employment are shown in Fig. 1. The solid line shows the deviation of total employment from the steady-state value when a positive productivity shock occurs, and the dotted line expresses the case without the shock. The fluctuations in total employment are large when the short-term employment ratio is large.

Table 3. Short-term employment ratio and coefficient of variation

Short-term employment ratio	10%	20%	30%	40%	50%
Long-term new hiring	7.24691e-08	1.49606e-07	2.31878e-07	3.19814e-07	4.14021e-07
Long-term employment	1.32467e-08	2.73466e-08	4.23851e-08	5.8459e-08	7.56792e-08
Short-term new hiring	2.09602e-05	2.09662e-05	2.09726e-05	2.09794e-05	2.09867e-05
Short-term employment	5.96988e-06	5.97158e-06	5.97339e-06	5.97533e-06	5.97741e-06
Total employment	5.97833e-07	1.19585e-06	1.79407e-06	2.39252e-06	2.99125e-06
Long-term employment wage	0.00315955	0.00316001	0.0031605	0.00316103	0.00316159
Short-term new hiring wage	0.00183115	0.00183142	0.00183171	0.00183202	0.00183235
Production	0.00315955	0.00316001	0.0031605	0.00316102	0.00316158
Consumption	0.00315955	0.00316001	0.0031605	0.00316102	0.00316158

Table 3 shows the short-term employment ratio and coefficient of variation for each variable corresponding to the expected temporary productivity shock. The fluctuations in short-term employment are larger than those of long-term employment, and thus, an increase in the short-term employment ratio amplifies the fluctuations in total employment. The large variations in short-term employment come from the short-term contract, which stipulates the same wage level during the contract periods. Additionally, fluctuations in production, composed of long-term and short-term employment, increase when the short-term employment ratio is increased due to the rise in employment variations. Moreover, from (7), the variations in consumption are large when the fluctuations in production are large. Matsue (2019) also shows, using a dynamic labor demand model, that an increase in the short-term employment ratio leads to an increase in employment fluctuations. Then, the high variations in short-term employment are caused by the assumption that firms do not incur the adjustment costs of short-term new hiring.

4. Conclusion

This study provides a dynamic framework with a long-term and a short-term employment contract, both of which have a predetermined duration. The numerical experiments with the proposed model show that increasing the short-term employment ratio amplifies the variations in total employment, which is consistent with empirical evidence. Consequently, the large fluctuations in employment bring about the large fluctuations in production and consumption.

Nevertheless, even though the model in this study focuses on short-term employment contracts, it could be extended to consider the effects of other aspects of the labor market, such as employment protection legislation and trade unions, on employment dynamics and economic fluctuations. Moreover, further empirical research on the parameter values in the numerical analysis should be undertaken. These topics are left for future research.

Appendix. Steady-state values

Consider the steady state $w^l_{t+1} = w^l_t = w^l$, $w^s_{t+1} = w^s_t = w^s$, $h^l_{t+1} = h^l_t = h^l$, $h^s_{t+1} = h^s_t = h^s$, $Y_{t+1} = Y_t = Y$, $C_{t+1} = C_t = C$ and $A_{t+1} = A_t = A$. Moreover, $\gamma = \mu$ is assumed. Then, from (1)–(7) and the production function, the following equations are obtained:

$$L^l = (4 - 6\delta + 4\delta^2 - \delta^3)h^l \tag{A1}$$

$$L^s = (2 - \sigma)h^s \tag{A2}$$

$$w^l = \alpha A \left[\frac{(4-6\delta+4\delta^2-\delta^3)h^l}{(2-\sigma)h^s}\right]^{\alpha-1} \tag{A3}$$

$$w^s = (1 - \alpha)A \left[\frac{(4-6\delta+4\delta^2-\delta^3)h^l}{(2-\sigma)h^s}\right]^{\alpha} \tag{A4}$$

$$\frac{w^l}{C} = a(L^l)^\gamma \tag{A5}$$

$$\frac{w^s}{C} = b[(2 - \sigma)h^s]^\gamma \tag{A6}$$

$$Y = C \tag{A7}$$

$$Y = A(L^l)^\alpha (L^s)^{1-\alpha} \tag{A8}$$

The steady-state values of w^l and w^s are obtained by (A1) and (A3)–(A6). By substituting (A1) into (A5) to eliminate L^l, we obtain the following:

$$\frac{w^l}{C} = a[(4 - 6\delta + 4\delta^2 - \delta^3)h^l]^\gamma \tag{A9}$$

By substituting (A9) into (A6) to eliminate C, we obtain the following:

$$\frac{w^l}{w^s}=\frac{a}{b}\left[\frac{(4-6\delta+4\delta^2-\delta^3)h^l}{(2-\sigma)h^s}\right]^{\gamma} \tag{A10}$$

By substituting (A3) and (A4) into (A10) to eliminate w^l and w^s, we have:

$$\frac{(4-6\delta+4\delta^2-\delta^3)h^l}{(2-\sigma)h^s}=\left[\frac{\alpha b}{(1-\alpha)a}\right]^{\frac{1}{1+\gamma}} \tag{A11}$$

By substituting (A11) into (A3) to eliminate $(4-6\delta+4\delta^2-\delta^3)h^l/(2-\sigma)h^s$, the steady-state value of w^l is obtained:

$$w^l=\alpha A\left[\frac{\alpha b}{(1-\alpha)a}\right]^{\frac{\alpha-1}{1+\gamma}} \tag{A12}$$

Moreover, by substituting (A11) into (A4) to eliminate $(4-6\delta+4\delta^2-\delta^3)h^l/(2-\sigma)h^s$, the steady-state value of w^s is obtained:

$$w^s=(1-\alpha)A\left[\frac{\alpha b}{(1-\alpha)a}\right]^{\frac{\alpha}{1+\gamma}} \tag{A13}$$

Now, let us derive the steady-state values of h^l, L^l, h^s, and L^s. By substituting (A1), (A2), and (A7) into (A8) to eliminate L^l, L^s, and Y, we obtain the following:

$$\frac{C}{(4-6\delta+4\delta^2-\delta^3)h^l}=A\left[\frac{(4-6\delta+4\delta^2-\delta^3)h^l}{(2-\sigma)h^s}\right]^{\alpha-1} \tag{A14}$$

Substituting (A11) into (A14) to eliminate $(4-6\delta+4\delta^2-\delta^3)h^l/(2-\sigma)h^s$, we obtain the following:

$$\frac{C}{(4-6\delta+4\delta^2-\delta^3)h^l}=A\left[\frac{\alpha b}{(1-\alpha)a}\right]^{\frac{\alpha-1}{1+\gamma}} \tag{A15}$$

(A9) is transformed as follows:

$$(4-6\delta+4\delta^2-\delta^3)h^l=\left(\frac{w^l}{a}\right)^{\frac{1}{1+\gamma}}\left[\frac{C}{(4-6\delta+4\delta^2-\delta^3)h^l}\right]^{\frac{-1}{1+\gamma}} \tag{A16}$$

By substituting (A15) into (A16) to eliminate $C/(4-6\delta+4\delta^2-\delta^3)h^l$, we obtain the following:

$$(4-6\delta+4\delta^2-\delta^3)h^l=\left(\frac{1}{a}\right)^{\frac{1}{1+\gamma}}\left(\frac{w^l}{A}\right)^{\frac{1}{1+\gamma}}\left[\frac{\alpha b}{(1-\alpha)a}\right]^{\frac{1-\alpha}{(1+\gamma)^2}} \tag{A17}$$

By substituting (A12) into (A17) to eliminate w^l/A, the steady-state value of h^l is obtained:

$$h^l=\frac{1}{4-6\delta+4\delta^2-\delta^3}\left(\frac{\alpha}{a}\right)^{\frac{1}{1+\gamma}} \tag{A18}$$

By substituting (A18) into (A1) to eliminate $(4-6\delta+4\delta^2-\delta^3)h^l$, the steady-state value of L^l is obtained:

$$L^l = \left(\frac{\alpha}{a}\right)^{\frac{1}{1+\gamma}} \tag{A19}$$

By substituting (A18) into (A11) to eliminate $(4-6\delta+4\delta^2-\delta^3)h^l$, the steady-state value of h^s is obtained:

$$h^s = \frac{1}{2-\sigma}\left(\frac{1-\alpha}{b}\right)^{\frac{1}{1+\gamma}} \tag{A20}$$

By substituting (A20) into (A2) to eliminate $(2-\delta)h^s$, the steady-state value of L^s is obtained:

$$L^s = \left(\frac{1-\alpha}{b}\right)^{\frac{1}{1+\gamma}} \tag{A21}$$

By substituting (A19) and (A21) into (A8) to eliminate L^l and L^s, the steady-state value of Y is obtained:

$$Y = A\left(\frac{\alpha}{a}\right)^{\frac{\alpha}{1+\gamma}}\left(\frac{1-\alpha}{b}\right)^{\frac{1-\alpha}{1+\gamma}} \tag{A22}$$

By substituting (A22) into (A7) to eliminate Y, the steady-state value of C is obtained:

$$C = A\left(\frac{\alpha}{a}\right)^{\frac{\alpha}{1+\gamma}}\left(\frac{1-\alpha}{b}\right)^{\frac{1-\alpha}{1+\gamma}}$$

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