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Immigration policy in a two sector model

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Immigration policy in a two sector model[†]

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Abstract

Throughout the world, some countries consider immigration policies to address labor supply difficulties. Particularly because OECD countries typically have an aging society with fewer children, immigration policies are examined continually. Our paper sets a two-sector model, with a high-skill sector and a low-skill sector, for assessment of immigration policies of two types: immigration for the high-skill sector and immigration for the low-skill sector. Results obtained from our study show that immigration has a positive effect on employment of the native people or a negative effect depending on production technologies used in the economy.

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1. Introduction

Throughout the world, some countries continually consider immigration policies to address labor supply difficulties. In OECD countries, because they typically have an aging society with fewer children, immigration policies are particularly examined.

[Insert Fig.1 around here.]

One important discussion about immigration persists: does immigration bring about job losses of native people or not? The increased labor supply associated with immigration, reduces the labor market wage rate. With wage rate rigidity, the unemployment rate increases because of an increase in the labor supply of immigration.

Regarding the related literature, Borjas (2003), Edo (2017), Dustmann et al. (2017), and others describe negative effects of immigration on the employment of the native people. By contrast, Basten (2019), Fulanetto and Robstad (2019), Esposito (2020), and others have described positive effects of immigration on the employment of the native people. Razin and Sadka (1999, 2000) examined immigration policy for low-skill labor and examined how pension benefits are determined in a small open economy and in a closed economy.

After setting a two-sector model with a high-skill sector and a low-skill sector, we consider immigration policies of two types: for immigration in the high-skill sector and for immigration in the low-skill sector. This setting resembles that used by Cassarico and Devillanova (2003). Results of these analyses are presented as shown below, depending on production technology and on whether immigration has a positive effect or a negative effect on the employment of the native people. If the sector has decreasing marginal productivity of labor, then immigration for the sector reduces the employment of the native people. However, even if the employment of native people is reduced in the sector, the two-sector model shows that the employment of native people increases in the other sector.

If immigration is considered in the sector of the linear production function, then the employment of native people does not change: production technologies affect immigration and the employment of the native people. This discussion emphasizes consideration of capital accumulation. By virtue of capital accumulation, savings by immigration raise capital accumulation. Then increased capital accumulation raises the wage rate of the sector, thereby pulling up employment of the native people. Our paper presents both positive and negative effects of immigration on the employment of native residents. As demonstrated by Krieger (2004), immigration for the low-skill sector can raise employment of native people in the high-skill sector. This result depends on the production technology. Therefore, given the production technology, immigration in the high-skill sector can raise the employment of native residents in the high-skill sector.

The remainder of the discussion on this topic consists of the following. Section 2 sets the model. Section 3 derives the equilibrium. Section 4 presents the respective examinations of immigration policy for the high-skill sector and low-skill sector. Sections 5 and 6 respectively describe production technologies of other types and describe examinations of how immigration affects employment of the native residents. Section 7 sets the model with pension and examines how the immigration policy affects on the pension benefit. Section 8 concludes our manuscript.

2. Model

The model economy in this paper consists of agents of two types: households and firms.

2.1 Households

Individuals live in two periods: young and old periods. The utility function u_t is assumed as

$$u_t = \alpha ln c_{1t} + (1-\alpha) ln c_{2t+1}, 0 < \alpha < 1. \quad (1)$$

Therein, c_{1t} and c_{2t+1} respectively denote consumption in the young period and old period. Individuals work in the young period to obtain wage income and obtain capital income in the old period. Then the budget constraint in young and old period are shown respectively as follows:

$$\overline{w}_t = c_{1t} + s_t, \quad (2)$$

$$(1 + r_{t+1})s_t = c_{2t+1}. \quad (3)$$

In those equations, $\overline{w}_t$ denotes the wage income. Also, s_t denotes savings. Older people obtain the capital income at the rate of interest rate r_{t+1}. The optimal allocations of household are given as

$$c_{1t} = \alpha \overline{w}_t, \quad (4)$$

$$c_{2t+1} = (1 + r_{t+1})(1-\alpha)\overline{w}_t. \quad (5)$$

2.2 Firms

Firms of two types are assumed to exist. The production functions of firms are assumed as follows.

High skill sector $$Y_{1t} = AK_t^{\theta} L_{1t}^{1-\theta}, 0 < A, 0 < \theta < 1. \quad (6)$$

Low skill sector $$Y_{2t} = BL_{2t}, 0 < B. \quad (7)$$

Both high-skill and low-skill sectors produce the final goods, which are homogeneous between two sectors. However, in the high-skill sector, final good Y_{1t} is produced by inputting capital stock K_t and labor L_{1t}. However, in the low-skill sector, final good Y_{2t} is produced by inputting only labor L_{2t}

This paper assumes that the training cost σ is necessary to work in the high-skill sector. The training cost differs between individuals. The distribution of training cost is assumed to be $[0, \overline{\sigma}]$ and is assumed to be distributed uniformly.

3. Equilibrium

The wages in the high-skill and low-skill sectors are shown respectively as follows in the competitive market.

$$w_{1t} = A(1-\theta)K_t^{\theta}L_{1t}^{-\theta}, \tag{8}$$

$$w_{2t} = B. \tag{9}$$

We assume the case of $w_{1t} > w_{2t}$. Individuals with low training cost σ can work in the high-skill sector as demonstrated by the model of Caselli (1999). Razin and Sadka (1999, 2000) consider the training cost. However, because of high training costs, individuals with high training cost σ do not work in the high-skill sector. Then, the training cost of indifferent individuals between high-skill and low-skill sectors is given as

$$A(1-\theta)AK_t^{\theta}L_{1t}^{-\theta} - \sigma_t^* = B. \tag{10}$$

That is, the individuals of $[0, \sigma^*]$ work in the high-skill sector. Individuals of $[\sigma^*, \bar{\sigma}]$ work in the low-skill sector. Then, if the population size of younger people is L, the labor supply in the respective sectors is given as

$$L_{1t} = \frac{\sigma_t^*}{\bar{\sigma}}L, \text{ and} \tag{11}$$

$$L_{2t} = \frac{\bar{\sigma} - \sigma_t^*}{\bar{\sigma}}L. \tag{12}$$

Then, considering (10) and (11), one obtains the following equation:

$$A(1-\theta)K_t^{\theta}\left(\frac{\sigma_t^*}{\bar{\sigma}}L\right)^{-\theta} = B + \sigma_t^*. \tag{13}$$

Defining the left-hand-side and the right-hand-side of (13), respectively, as L and R, one can obtain the unique σ_t^*; σ_t^* rises with an increase in the capital stock.

[Insert Fig. 2 around here.]

Assuming full depreciation of capital stock in a period, capital accumulation can be shown as

$$K_{t+1} = (1-\alpha)\left(L\int_0^{\sigma_t^*}\left(A(1-\theta)K_t^{\theta}\left(\frac{\sigma_t^*}{\bar{\sigma}}L\right)^{-\theta} - \sigma\right)\frac{1}{\bar{\sigma}}d\sigma + \frac{\bar{\sigma} - \sigma_t^*}{\bar{\sigma}}LB\right). \tag{14}$$

Considering (10) and (14), one can obtain the dynamics of capital stock as

$$K_{t+1} = (1-\alpha)L\left(\frac{\sigma_t^{*2}}{2\bar{\sigma}} + B\right). \tag{15}$$

Because σ_t^* rises with K_t and diminishing marginal productivity of K_t, the unique steady state can be obtained as shown by the following Fig. 3.

[Insert Fig. 3 around here.]

The labor share of the high-skill sector σ^* and capital stock K at the steady state are given by the following equations.

$$A(1-\theta)K^{\theta}\left(\frac{\sigma^*}{\bar{\sigma}}L\right)^{-\theta} = B + \sigma^* . \tag{16}$$

$$K = \alpha L\left(\frac{\sigma^{*2}}{2\bar{\sigma}} + B\right). \tag{17}$$

4. Immigration Policy

This section presents consideration of the immigration policy. First, we consider the case of immigration for the low-skill sector. After analysis of this case, we examine immigration for the high-skill sector.

4.1 Immigration for the low-skill sector

We consider the case of immigration for the low-skill sector. The training cost of immigrant is assumed by $\sigma_t = \bar{\sigma}$. If the number of immigrants is given as δL, then, the capital stock in t+1 is given as

$$K_{t+1} = (1-\alpha)\left(L\int_0^{\sigma_t^*}\left(A(1-\theta)K_t^{\theta}\left(\frac{\sigma_t^*}{\bar{\sigma}}L\right)^{-\theta} - \sigma\right)\frac{1}{\bar{\sigma}}d\sigma + \frac{\bar{\sigma}-\sigma_t^*}{\bar{\sigma}}LB + \delta LB\right). \tag{18}$$

For given K_t, immigrants for the low-skill sector raise the capital stock in t+1 because the immigrants provide savings. Immigrants obtain wage income B and allocate αB for savings. Because of immigration size δL, one can obtain the capital stock dynamics as shown by Eq. (18).

Even if one considers immigration for the low-skill sector, the labor share of the high-skill sector does not change during t period, as shown by (13). However, in the t+1 period, the capital stock increases, as does the wage rate in the high-skill sector; then the share of the high-skill sector increases. Consequently, the native people who work in the high-skill sector increase. This immigration policy is beneficial for the native residents because many native people can work in the high-skill sector and can obtain a higher wage income than they can from wages earned in the low-skill sector.

4.2 Immigration for the high-skill sector

We consider the case of immigration for the low-skill sector. The immigrant training cost is assumed as $\sigma_t = 0$. If the number of immigrants is given as δL, then the share of the high-skill sector is given as

$$A(1-\theta)K_t^{\theta}\left(\frac{\sigma_t^*}{\bar{\sigma}}L + \delta L\right)^{-\theta} = B + \sigma_t^*. \tag{19}$$

Because of δL, σ_t^* decreases: immigration for the high-skill sector reduces the labor supply of native people in the high-skill sector. This reduction is not beneficial for native people because of job losses in the high-skill sector of native residents.

Following are the dynamics of capital stock, given as

$$K_{t+1} = (1-\alpha)L\left(\frac{\sigma_t^{*2}}{2\bar{\sigma}} + \delta A(1-\theta)K_t^{\theta}\left(\frac{\sigma_t^*}{\bar{\sigma}}L + \delta L\right)^{-\theta} + B\right). \quad (20)$$

As shown by (20), immigration for the high-skill sector raises the capital stock at *t*+1 period because of an increase in the savings of immigrants for the high-skill sector. Therefore, by virtue of an increase in K_{t+1}, the wage rate of the high-skill sector increases. Then the share of labor supply in the high-skill sector σ_t^* increases: even if the immigration for the high-skill sector reduces the share of labor supply of native people at the high-skill sector, an increase in capital stock recovers the share of labor supply of native people at the high-skill sector. The following proposition can be established.

Proposition 1

Immigration for the low-skill sector raises the share of labor supply of native people at the high-skill sector. However, immigration for the high-skill sector reduces the share of labor supply of native people at the high skill sector if the increase in capital stock is small.

In this model, the production function in the low-skill sector is a linear function of the labor supply. Because of the linear function, an increase in labor supply at the low-skill sector does not change the wage rate of the low-skill sector. However, because of a decrease in marginal productivity of labor supply at the high-skill sector, immigration for the high-skill sector reduces the wage rate of the high-skill sector and reduces the labor share of native people of the high-skill sector because of training costs.

The following section presents consideration of the other types of production function to examine how the assumptions of production functions in high-skill and low-skill sectors affect the results.

5. Case of linear function of the high-skill sector

This section presents consideration of a case in which the production function of the high-skill sector is the linear technology. The production function of each sector is assumed as shown below.

High skill sector $\quad Y_{1t} = AL_{1t}, 0 < A. \quad (21)$

Low skill sector $\quad Y_{2t} = BK_t^{\theta}L_{2t}^{1-\theta}, 0 < B, 0 < \theta < 1. \quad (22)$

We consider the high skill sector as the R&D sectors as the endogenous growth theory considers. Then, considering the competitive market, the wage rates of the respective sectors are

$$w_{1t} = A, \quad (23)$$

$$w_{2t} = B(1-\theta)K_t^{\theta}L_{2t}^{-\theta}. \quad (24)$$

Assuming the case of $w_{1t} > w_{2t}$, σ^* is given such that the following equation holds:

$$B(1-\theta)K_t^{\theta}\left(\frac{\bar{\sigma}-\sigma^*}{\bar{\sigma}}L\right)^{-\theta} = A - \sigma_t^*. \quad (25)$$

An increase in capital stock K_t reduces the labor share of the high-skill sector because the wage rate of the low-skill sector increases. The dynamics of capital stock follows:

$$K_{t+1} = (1-\alpha)L\left(\frac{\sigma_t^{*2}}{2\bar{\sigma}} + B(1-\theta)K_t^{\theta}\left(\frac{\bar{\sigma}-\sigma_t^*}{\bar{\sigma}}L\right)^{-\theta}\right). \quad (26)$$

5.1 Immigration for the high-skill sector

Next, immigration for the high-skill sector is examined. The training cost of immigration is assumed as $\sigma_t = 0$. If we consider the immigration size for the high-skill sector as δL, then the labor share given by (25) does not change because of the linear technology of the high-skill sector. The following shows the capital stock dynamics as

$$K_{t+1} = (1-\alpha)L\left(\frac{\sigma_t^{*2}}{2\bar{\sigma}} + B(1-\theta)K_t^{\theta}\left(\frac{\bar{\sigma}-\sigma_t^*}{\bar{\sigma}}L\right)^{-\theta} + \delta A\right). \quad (27)$$

Therefore, immigration for the high-skill sector increases the capital stock in *t*+1 period because of savings deriving from immigration. Because of capital stock in *t*+1 period, the wage rate of the low-skill sector rises. This effect decreases the labor share of the high-skill sector of native people.

5.2 Immigration for the low-skill sector

Conversely, we consider the case of immigration for the low-skill sector. The training cost of immigration is assumed as $\sigma_t = \bar{\sigma}$. If one considers the immigration size for the low-skill sector as δL, then the labor share is determined such that the following condition holds:

$$B(1-\theta)K_t^{\theta}\left(\frac{\bar{\sigma}-\sigma_t^*}{\bar{\sigma}}L + \delta L\right)^{-\theta} = A - \sigma_t^*. \quad (28)$$

Therein, δL reduces the marginal productivity of labor and wage rate of the low-skill sector. Then the labor share of the high-skill sector σ_t^* rises. The following shows the dynamics of capital stock:

$$K_{t+1} = (1-\alpha)L\left(\frac{\sigma_t^{*2}}{2\bar{\sigma}} + (1+\delta)B(1-\theta)K_t^{\theta}\left(\frac{\bar{\sigma}-\sigma_t^*}{\bar{\sigma}}L + \delta L\right)^{-\theta}\right). \quad (29)$$

In that equation, δL raises the capital stock in *t*+1 period directly. However, an increase in σ_t^* raises the capital stock in *t*+1. Then, the following proposition can be established.

Proposition 2

If the high-skill sector is the linear production technology and if the low-skill sector has decreasing marginal productivity of labor, then immigration for the high-skill sector raises the high-skill labor supply provided by the native people.

It is noteworthy that Prop1 and Prop2 depend on the production technology of linear production function. The following section describes consideration of the case of decreasing marginal productivity of labor in both skill sectors, as assumed by Caselli (1999).

6. Case of decreasing marginal productivity of labor in both sectors

As the model set by Caselli (1999), we consider the following model.

High skill sector $$Y_{1t} = AK_{1t}^{\theta}L_{1t}^{1-\theta}, 0 < A. \tag{30}$$

Low skill sector $$Y_{2t} = BK_{2t}^{\theta}L_{2t}^{1-\theta}, 0 < B. \tag{31}$$

Considering the competitive market, the interest rate is equal to the marginal productivity of capital stock of both sectors, as

$$1 + r_t = \theta AK_{1t}^{\theta}L_{1t}^{1-\theta} = \theta BK_{2t}^{\theta}L_{2t}^{1-\theta}, \tag{32}$$

where $K_t = K_{1t} + K_{2t}$.

The wage rates of the respective sectors are presented below.

High skill sector $$w_{1t} = (1-\theta)AK_{1t}^{\theta}\left(\frac{\sigma_t^*}{\bar{\sigma}}L\right)^{-\theta}, \tag{33}$$

Low skill sector $$w_{2t} = (1-\theta)BK_{2t}^{\theta}\left(\frac{\bar{\sigma}-\sigma_t^*}{\bar{\sigma}}L\right)^{-\theta}. \tag{34}$$

The labor share σ_t^* is determined such that the following equation holds.

$$(1-\theta)AK_{1t}^{\theta}\left(\frac{\sigma_t^*}{\bar{\sigma}}L\right)^{-\theta} - \sigma_t^* = B(1-\theta)K_t^{\theta}\left(\frac{\bar{\sigma}-\sigma_t^*}{\bar{\sigma}}L\right)^{-\theta}. \tag{35}$$

The following shows the dynamics of capital stock:

$$K_{t+1} = \alpha L\left(\frac{\sigma_t^{*2}}{2\bar{\sigma}} + B(1-\theta)K_t^{\theta}\left(\frac{\bar{\sigma}-\sigma_t^*}{\bar{\sigma}}L\right)^{-\theta}\right). \tag{36}$$

In this case, immigration for the high-skill sector reduces the labor share of native people in the high-skill sector because of a decrease in the marginal productivity of labor and the wage rate of the high-skill sector. If we consider immigration for the low-skill sector, then the labor share of native people in the low-skill sector decreases because of a decrease in marginal productivity of labor and wage rate of the low-skill sector. However, an increase in labor supply in low-skill sector raises the capital stock in low-skill sector because of an increase in the marginal productivity of capital stock. Then, this effect raises the wage rate at low-skill sector and the movement of native workers from low-skill to high skill sector is less than the model of section 4.

As presented in the discussion presented above, whether immigration reduces the labor opportunities of native residents depends on the production technologies used in the economy.

7. Pension

Many reports have described pensions and immigration. As described in this section, based on the model of section 4, we set the immigration model with a pension. Then, the household budget constraint is shown as follows.

$$c_{1t} + \frac{c_{2t+1}}{1+r_{t+1}} = (1-\tau)w_{it} + \frac{p_{t+1}^i}{1+r_{t+1}}, i = l, h \tag{37}$$

The pension benefit p_{t+1}^i depends on the wage income obtained during the younger period. In the equation, τ denotes the contribution rate. The benefit rate is defined as ε^i. The pension benefit in the old period is shown by $\varepsilon^i w_{it+1}$. Then, utility maximization can be reduced to the following household saving as

$$s_t^i = (1-\alpha)(1-\tau)w_{it} - \frac{\alpha p_{t+1}^i}{1+r_{t+1}}, i = 1,2. \tag{38}$$

Subsequently, considering capital accumulation and immigration for the low-skill sector, we can obtain the following capital accumulation equation as

$$K_{t+1} = (1-\alpha)L\left(\int_0^{\sigma_t^*}\left((1-\tau)A(1-\theta)K_t^\theta\left(\frac{\sigma_t^*}{\bar{\sigma}}L\right)^{-\theta} - \sigma\right)\frac{1}{\bar{\sigma}}d\sigma + \frac{\bar{\sigma}-\sigma_t^*}{\bar{\sigma}}B + \delta B\right) - \alpha L\left(\frac{p_{t+1}^h}{1+r_{t+1}} + \frac{(1+\delta)p_{t+1}^l}{1+r_{t+1}}\right). \tag{39}$$

The government budget constraint of the pension system can be presented as

$$\sigma_t^* p_{t+1}^h + (\bar{\sigma}-\sigma_t^*)p_{t+1}^l = \tau(\sigma_{t+1}^* w_{1t+1} + (\bar{\sigma}-\sigma_{t+1}^*)w_{1t+1}). \tag{40}$$

The left-hand-side of (40) denotes the total pension benefit. The right-hand-side shows the total revenue for pension benefit. We assume the benefit rule as the respective expressions of

$$p_{t+1}^h = \varepsilon^h w_{1t+1}, \tag{41}$$

$$p_{t+1}^l = \varepsilon^l w_{2t+1}. \tag{42}$$

If the benefit rates ε^h and ε^l are fixed (we assume $\varepsilon^h w_{1t+1} > \varepsilon^l w_{2t+1}$), then the contribution rate τ is determined to satisfy (40). If individuals work in the high-skill sector during the younger period, then they can obtain pension benefit (41). Otherwise, they obtain pension benefit (42).

Immigration for the low-skill sector raises capital accumulation in *t*+1 period. Then, the wage income of the high-skill sector in *t*+1 period rises. A pensioner of the high-skill sector can obtain a greater pension benefit.

8. Conclusion

Our paper presents examination of whether the immigration policy brings about a job loss of native residents or not. The results depend on the production technology. If one considers the decreasing marginal productivity of labor, then the immigrant for the sector with decreasing marginal productivity of labor reduces the labor supply of native residents. However, these analyses use linear production function technology; an immigrant for the sector of linear production technology does not reduce the labor supply of native people. Even if the immigrant causes a decrease in the labor supply, the labor supply of native residents in the sector with decreasing marginal productivity can be increased by virtue of an increase in capital accumulation brought about by the savings provided by the immigrant.

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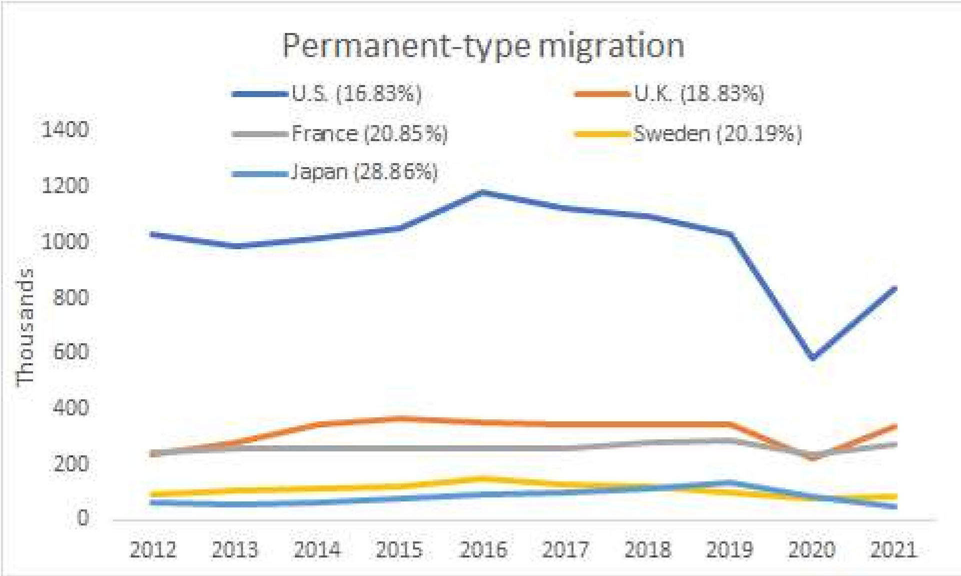

Fig.1: Permanent-type migration (The brackets show the elderly (over 65 years old) population ratio.) (Data: International Migration Outlook 2022, OECD Data.)

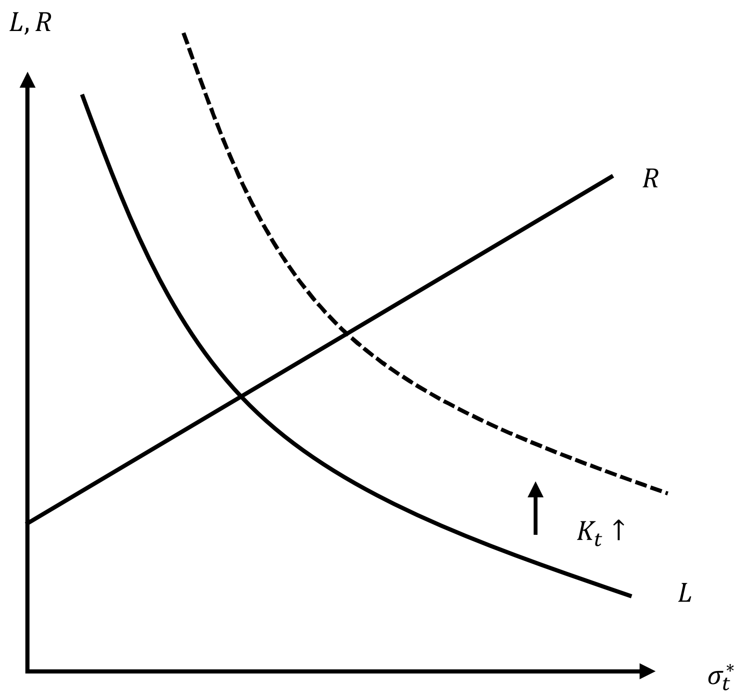

Fig. 2: Labor share of the high-skill sector.

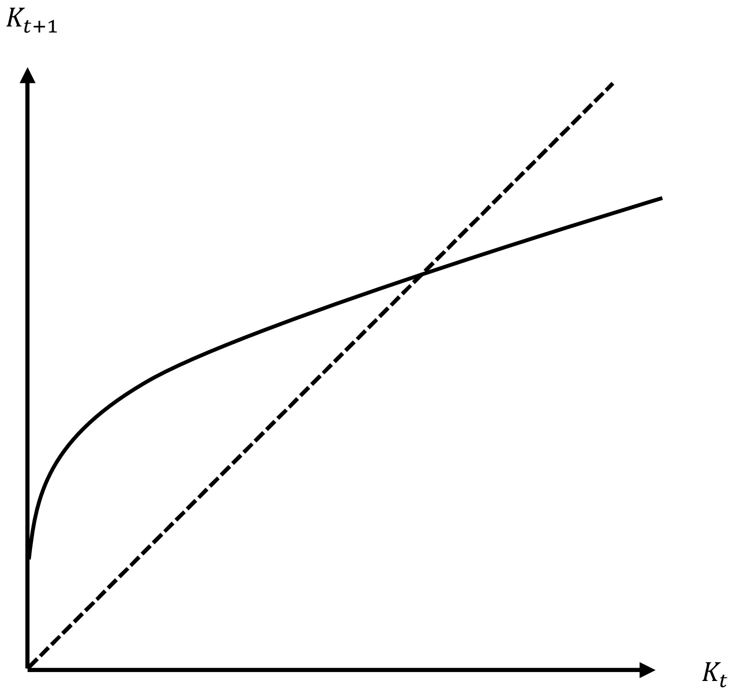

Fig. 3: Dynamics of capital stock.