Endogenous capital agglomeration:
A consideration of the expansion in assets disparity between countries

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Abstract

This paper constructs a two-factor, two-country model with transportation costs. Its purpose is to investigate how determination of firms' location affects the distribution of assets between the countries if assets are traded internationally.

The main findings in this paper are as follows. First, in the short-run with given capital possession, the share of firms located in the North which owes larger capital is more than 1/2. The wage in the North is higher than in the South with smaller capital. When the elasticity of substitution across varieties, σ, is greater than or equal to 3/2, the lower transportation costs are, the smaller the disparities in wage and income between the countries are. On the other hand, when σ is less than 3/2, there is the transportation cost which brings about the maximum income and wage differentials. There is a possibility that the disparity in capital possession remains in the long-run if $\sigma<3/2$. In this case, if transportation costs are higher than the critical value, the disparities in capital possessions, wage and income expand in the long-run. On the other hand, they are exhausted for any σ if transportation costs are low enough. However, the smaller σ is, the narrower the range of the transportation costs is, under which the assets disparity disappears.

JEL classification: F1; F21; R12; O11
Key words: assets agglomeration, imperfect competition, trade costs

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1. Introduction

One of the features of the international economy is that the disparities in wage and income between developed countries and NIEs (Newly industrializing countries) come to converge while those between developed countries and LDCs (less developed countries) tend to expand. Considering "the home market effects" introduced by Krugman (1980), Ishiguro (2004) points out the possibility that disparity in capital possession between countries brings about wage differential between them. Supposing that each good is produced by increasing returns to scale technology with transportation costs, it is profitable for firms to produce their goods in a larger market and export them to a region with a small market. Therefore there is a tendency for the larger market to obtain a larger share of firms producing differentiated goods than their share of demand for them. Thus, a rich country which holds a large amount of capital attracts more firms due to its large domestic market, and the wage there rises because of high labor demand. The income differential between the country with high capital possession and the country with low capital possession expands to get greater than the income differential induced by the gap in capital possession. If a firm thinks that transportation costs harm its profits seriously, it chooses to produce in a developed country where it can enjoy a large market but has to pay higher wage for production. Because firms come to concentrate in a country with high wage, the wage differential expands. If there is a tendency that high income can yield high savings, expansion in wage differential between the countries brings about expansion in the disparity in assets possession between them. If we admit to the circular causality, that is, high possession of property induces high income leading to even higher property possession, we can point out the possibility that the differential in capital possession between the countries expands cumulatively. Therefore, there is a tendency that the rich countries become richer because they are rich. But if a firm put greater emphasis on a risk of high wage negatively impacting profits, it chooses to produce in a developing country in which wage is low. Since, in this case, firms move into the country with low wage, the wage differential can contract. This may result in convergence in capital possessions of each country in the long-run. The purpose of this paper is to obtain the conditions under which international trade leads to agglomeration of world assets in a large country in the case that assets are transferred between two countries by using a two-factor general equilibrium model with transportation costs.

Since the beginning of 1990s, various analyses based on "the home market effects" have investigated into the relation between trade costs and location of firms. Krugman (1991), Krugman and Venables (1995), Fujita, Krugman and Venables (1999), and Puga (1999) obtain the condition for the agglomeration of firms in one region (No-Black-Hole Condition: NBHC.) Puga investigates firms' profits to obtain NBHC by assuming that the profits are distributed to the region where firms locate themselves.[1] That is, a firm is assumed to be owned by the household in the region where the firm produces goods. Because it is supposed in these analyses that labor is the only production factor and that no entry costs are incurred, which result in zero profits, the ownerships of firms have no values. However, if entry costs exist, ownerships of the

[1] Ishiguro (2005) shows that NBHCs in Krugman and the others contain this condition implicitly though they are obtained by investigating wage rate.

existing firm have positive values. In such a case, even if a firm changes its location, the ownership of the firm is not necessarily transferred at the same time. The reason is that the firm determines a production base to maximize its profits while households save through holding the ownership of firms as assets, and the move of property between the countries depends on the difference in net savings between them. However, the determination of location by the firm affects income through wage rate and also affects savings. The move of the property between the countries is affected by the determination of location by firms. Therefore, the determination of a firm's location and the move of its ownership need to be distinguished but to be taken into consideration simultaneously. Amiti (1998) and Martin and Ottaviano (1999) introduce capital as a production factor into a location model. However, they do not take into consideration the move of assets between countries. In this paper, we construct a general equilibrium model with two factors and two countries which are identical in every respect except in capital possession and investigate how determination of firms' location affects the distribution of assets between the countries if assets, i.e. the ownership of firms, are traded internationally. We will show the possibility that the disparity in capital possession remains in the long-run if the elasticity of substitution across varieties, σ, is smaller than 3/2. In this case, if transportation costs are higher than the critical value, the disparity in capital possessions, wage and income expand in the long-run. On the other hand, they are exhausted in the long-run for any σ if transportation costs are low enough. However, the range of transportation costs that allows asset disparity to disappear depends on values of σ, and the smaller σ is, the narrower the range gets.

This paper has the following structure. Section 2 presents a monopolistically competitive model on which the analysis in this paper is based. Section 3 proves analytically that the disparity in capital possession between countries brings about the wage differential between them by using the short-run equilibrium conditions. Section 4 observes the long-term equilibrium under which capital is transferred between the countries. Then it is shown whether to not the disparities in capital possessions, wage and income expand depends on values of the elasticity of substitution across varieties (the price elasticity of demand for variety) and transportation costs. Section 5 summarizes the conclusion. Furthermore we attempt to give account for the asset disparity between developed countries and developing countries by using the conclusion obtained in this paper.

2. The Model

The fundamental framework in this paper is a model based on a Kugman type model, which assumes two countries (North(country N), South(country S)), two factors (labor L_i, capital K_i; i=N, S) and one sector. In each county, there is endowed L labor and we denote the wage in the country i by w_i. Assuming the labor in the South as the numeraire, the wage in the South, w_S, is always equal to one.

A representative household has Cobb-Douglas preference between a CES aggregate of differentiated goods, X, and the real balance of financial assets holdings, A. Denoting consumption of variety h by d_h, and the number of differentiated goods produced in country i by k_i, the utility function of the representative household is

$$u = X^{\alpha} A^{1-\alpha} \tag{1}$$

$$X = \left[\int_0^K d_h^{\,1-1/\sigma} dh\right]^{1/(1-1/\sigma)} \quad , \quad \sigma > 1 \quad , \quad K = k_N + k_S ,$$

where σ is the elasticity of substitution across varieties. Such utility functions including the real balance of financial assets holdings were considered by Muellbauer and Portes (1978), Benassy (1975), Fama (1970) and Ono (1994). Ono argues that the possession of wealth, such as money, directly generates a utility. On the other hand, Fama, Muellbauer and Portes, Benassy, and Chapter 6 of Blanchard and Fischer (1989) obtain the indirect utility function which includes the present consumption and the balance of financial assets reflecting the level of desirable future consumption. They use the technique of dynamic programming which reduces a multi-period optimization problem to a sequence of two-period decision problem.[2] Especially, Fama derives such a type of indirect utility function with non-negative balance of assets holding of a household in each period.[3] Taking into consideration that it is difficult for households in developing countries to borrow internationally, we assume that, based on a fixed ratio, each household allocates its total amount of disposable money to consumption of differentiated goods and financial asset holdings in each period. Denoting the user price of variety h in country i by q_{hi}, the price index of X in country i, P_i, is expressed as follows:

$$P_i = \left[\int_0^K q_{hi}{}^{1-\sigma} dh\right]^{1/(1-\sigma)}. \qquad (2)$$

Expenditure of the household in country i, E_i, is

$$E_i = \int_0^K q_{hi} d_h dh + P_i A_i. \qquad (3)$$

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[2] By using backward induction, we can obtain the indirect utility from value function.

[3] The general method of a household's optimization in dynamic analysis is maximizing the discounted sum of utilities from consumption of goods in each period subject to its lifetime income as a budget constraint. The level of consumption in each period is independent from income and property of the household at the period based on the assumption that the household can borrow money as it needs on security of lifetime income. However, the households in developing countries experience the liquidity constraint because it is difficult for them to borrow internationally. In this paper, we assume that each household allocates its total amount of disposable money to differentiated goods and financial asset holdings with a myopic expectation towards future prices and income.

Let us also assume that each household provides one unit of labor for each period.

Differentiated goods are monopolistically competitive and produced with identical technologies. Trade of differentiated goods incurs "ice-berg" real costs τ: τ units of differentiated goods need to be shipped to receive one unit in the other country. Production of each variety requires one capital and β units of labor as marginal inputs. Let p_i be the producer price in country i, and x_i be the quantity of each variety produced in country i. The profits of each firm located in country i, π_i, are

$$\pi_i = p_i x_i - \beta x_i w_i \qquad (4)$$

When we assume that the location of a firm is free and that there are no relocation costs incurred, the profits of each firm are the same in both countries. The value of a firm on the stock market is the present discount value of all the future profits. Assuming that the household has a myopic expectation towards firm profits, the value of a firm is π/r where r denotes the interest rate.[4] Therefore, the budget constraints of the household in each country are

$$E_N = w_N + \frac{\pi}{r}\frac{K}{L}\phi_0(r+1), \qquad (5)$$

$$E_S = 1 + \frac{\pi}{r}\frac{K}{L}(1-\phi_0)(r+1). \qquad (6)$$

where ϕ_0 denotes the share of firms owned by the North to the total amount of capital stocks. Since it is assumed that w_S=1, we express w_N as w in the following. Taking into account the budget constraint of the household expressed by Eq. (3) and solving the maximizing problem of the household, we obtain the demand of the household in country i for differentiated good produced in country i, d_{ii}, the demand for differentiated

[4] Profits in each period are paid to the households which hold stocks at the beginning of period. Therefore, the value of a firm on the stock market is equal to the present discount value of all the future profits on and after the next period, π/r. See Appendix 1.

good produced in country j, d_{ji}, and the demand for A_i as

$$d_{ii} = \alpha E_i P_i^{\sigma-1} p_i^{-\sigma}, \qquad (7)$$

$$d_{ji} = \alpha E_i P_i^{\sigma-1} p_j^{-\sigma} \tau^{-\sigma}, \qquad (8)$$

$$A_i = (1-\alpha) E_i / P_i . \qquad (9)$$

Eqs. (7) and (8) show that each firm faces a constant price elasticity of demand, σ. Therefore, the producer price of any differentiated good is

$$p_i = w_i \beta\sigma / (\sigma - 1). \qquad (10)$$

Substituting Eq. (10) into (4), we obtain profits as follows:[5]

$$\pi = \beta x_i \frac{1}{\sigma - 1} w_i . \qquad (11)$$

3. The Short-run Equilibrium

In this section, we consider a short-run equilibrium with given capital possession ϕ_0 in each country. In the following, we assume two countries are identical in every respect except for amount of capital possession. In this section, we assume that $\phi_0 > 1/2$.

In equilibrium, we obtain the price index of X in each country, P_i, the market clearing conditions for each variety and for stock as follows:

$$P_N = \frac{\beta\sigma}{\sigma-1}\left[k_N w^{1-\sigma} + k_S \delta\right]^{\frac{1}{1-\sigma}}, \qquad P_S = \frac{\beta\sigma}{\sigma-1}\left[k_N w^{1-\sigma}\delta + k_S\right]^{\frac{1}{1-\sigma}}, \qquad (12)$$

$$x_N = \frac{\alpha L(\sigma-1) w^{-\sigma}}{\beta\sigma}\left[\frac{E_N}{k_N w^{1-\sigma} + k_S\delta} + \frac{E_S\delta}{k_N w^{1-\sigma}\delta + k_S}\right], \qquad (13)$$

5 See Appendix 2.

$$x_S = \frac{\alpha L(\sigma - 1)}{\beta\sigma}\left[\frac{E_N\delta}{k_N w^{1-\sigma} + k_S\delta} + \frac{E_S}{k_N w^{1-\sigma}\delta + k_S}\right], \qquad (14)$$

$$K = \frac{(1-\alpha)L(E_N + E_S)r}{\pi}. \qquad (15)$$

where $\delta = \tau^{1-\sigma}$ $(0 \leq \delta \leq 1)$. When $\tau = 1$, $\delta = 0$, and when $\tau \to \infty$, $\delta \to 1$. Recalling $k_N + k_S = K$ and using Eqs. (13) and (14), the share of firms located in the North, γ is expressed as

$$\gamma = \frac{k_1}{K} = \frac{E_N(W - \delta) - E_S\delta(1 - W\delta)}{(W - \delta)(1 - W\delta)(E_N + E_S)}, \qquad (16)$$

where $W = w^{1-\sigma}$. Using Eqs. (13), (14), (16), we obtain

$$x_S = x_N w = \frac{\alpha\mu L(E_N + E_S)}{\beta K}, \qquad (17)$$

where $\mu = (\sigma - 1)/\sigma$, $0 < \mu < 1$. The profits in equilibrium are

$$\pi = \frac{\alpha(1-\mu)L(E_N + E_S)}{K}. \qquad (18)$$

The labor market equilibrium condition in the South is

$$L = K(1-\gamma)x_S\beta. \qquad (19)$$

Using Eqs. (17) and (19), we obtain

$$E_N + E_S = \frac{1}{\alpha\mu(1-\gamma)}. \qquad (20)$$

The labor market equilibrium condition in the North is

$$L = K\gamma x_N\beta. \qquad (21)$$

From Eqs. (17), (20) and (21), the wage in the North is obtained as

$$w = \frac{\gamma}{1-\gamma}. \qquad (22)$$

Eq. (22) shows that the wage in the North, w, is 1 when firms are located equally between the two countries; and therefore, the further the share of firms located in the North, γ, exceeds 1/2, the larger w gets.

is larger than 1/2.

Using Eqs. (18), (20) and (22), the share of the North in expenditure, $e(=E_N/(E_N+E_S))$, can be written as

$$e = \alpha\mu\gamma + \alpha(1-\mu)\frac{1+r}{r}\phi_0 . \qquad (23)$$

Taking into account that the representative household has the Cobb-Douglas preference, the share of the North in assets demand, ϕ, is equal to the share of the North in expenditure: i.e. $\phi = e$. From Eqs (15), (18) and (20), the interest rate, r, is

$$r = \frac{\alpha(1-\mu)}{1-\alpha} . \qquad (24)$$

Substituting Eq. (24) into Eq. (23) gives e as

$$e = \alpha\mu\gamma + (1-\alpha\mu)\phi_0 . \qquad (25)$$

Using Eq. (25), we can rewrite Eq. (16) as

$$\gamma = \frac{eW(1-\delta^2)-\delta(1-W\delta)}{(1-W\delta)(W-\delta)} . \qquad (26)$$

γ is a function of W and δ and is continuous except at values which satisfy $\delta W = 1$ or $W = \delta$. The equilibrium is expressed by Eqs. (26) and (27) which we obtain by substituting Eq. (22) into the definition of W.

$$W = \left(\frac{\gamma}{1-\gamma}\right)^{\frac{-\mu}{1-\mu}} . \qquad (27)$$

It is difficult to solve for these two equations for γ and W explicitly. Therefore, we firstly investigate values of γ and W for $\delta=0$. Using Eqs. (25) and (26), we obtain γ, e for $\delta=0$ as

$$\gamma = e = \phi_0 > 1/2 . \qquad (28)$$

From Eqs. (22), (27) and (28), $w>1$, $W<1$ for $\delta=0$. Then, it is obtained that the autarky wage rate in the North exceeds 1.

Next, we will investigate in the inverse function of Eq. (26). From Eq. (27), γ is expressed as a function of W, i.e. $\gamma(W)$. Considering Eq. (25), the share of the North in expenditure, e, is also expressed as $e(W)$. Therefore, Eq. (26) can be rewritten as

$$W[\gamma(W)-\{1-e(W)\}]\delta^2+[1-(1+W^2)\gamma(W)]\delta+W[\gamma(W)-e(W)]=0. \qquad (29)$$

Leaving the domain for δ out of consideration, Eq. (29) shows that δ=1,-1 for W=1; i.e. γ=1/2.[6] Moreover, setting $W=\delta$ in Eq. (29), we find a unique solution, δ=1. Furthermore, because 1>W>0 for δ=0, we obtain

$$1>\gamma>1/2, \quad \delta<W<1 \qquad (30)$$

for $-1\leq\delta<1$; i.e. $0\leq\delta<1$. The North with more assets receives a greater amount of capital income than the South. With transportation costs, it is more profitable for firms to produce goods near a large market and export them to a country with a small domestic market, resulting in a larger share of firms in the North than the South. Therefore, labor demand gets relatively larger in the North, always allowing the wage rate there to exceed that in the South. Differential in assets possession between the countries brings about wage differential between them. The income differential between the North and the South expands to become greater than the income differential induced by assets possession. For this reason, the differential in the share of firms located in the North and in the South gets bigger than the differential induced by capital income, as well. Because γ cannot be defined when $W=\delta=1$, the WW curve expressed by Eq. (29) is discontinuous at δ=1. The implication that γ cannot be defined when δ=1 is that the location of firms is indeterminate without transportation costs.

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[6] Substituting W=1, γ=1/2 into Eq.(29) gives $(1-\alpha\mu)[\phi_0-(1/2)](\delta^2-1)=0$ which is satisfied when $\phi_0=1/2$ or $\delta=1,-1$. Because we assume $\phi_0>1/2$, we obtain $\delta=1,-1$.

Since Eq. (29) is a quadratic equation of δ, the number of real roots is 0, 1, or 2 for each value of W. Suppose the number of the vertex on the WW curve is more than two as shown in Fig.1. Now, let the vertex on the WW curve be point T. In the following part, variables corresponding to point T are accompanied by subscript T. In this case, the number of δ should be three and over for some values of W and Eq. (29) does not hold. Therefore, point T is unique and the form of the WW curve cannot be the one as shown in Fig. 1.

Next, we examine the possibility that the WW curve has the vertical segments as shown in Fig. 2. In such a case, there are δ_{R1} and δ_{R2} where $\partial W/\partial\delta=\infty$. However, $\partial W/\partial\delta$ should not be infinity for $0\leq\delta<1$, and the WW curve would never have the vertical segments as shown in Fig. 2.[7]

Now, let the two real roots of Eq. (29) be δ_1 and δ_2 ($\delta_1\leq\delta_2$) for a certain value of W. Using the relationship between solutions and coefficients, we obtain

$$\delta_1+\delta_2=\frac{-1+\gamma\left(1+W^2\right)}{\left[\gamma-(1-e)\right]W}, \qquad (31)$$

$$\delta_1\delta_2=\frac{\gamma-e}{\gamma-(1-e)}. \qquad (32)$$

From Eqs. (16) and (31), we find that there is the relation between e, W, and δ expressed with Eq. (33) at point T:[8]

$$\frac{e_T\left(W_T-\delta_T\right)}{1-W_T\delta_T}-\frac{\left(1-e_T\right)\left(1-W_T\delta_T\right)}{W_T-\delta_T}=0. \qquad (33)$$

Setting $\delta_T=0$ and using Eq. (28), we obtain

$$\phi_0 W_T=\frac{1-\phi_0}{W_T}. \qquad (34)$$

From Eqs. (27), (28) and (33), in case of $\delta_T=0$

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[7] See Appendix 3.
[8] See Appendix 4.

$$W_T^{\ 1-3\mu} = 1. \qquad (35)$$

Taking into account that $W_T \neq 1$, we find that $\delta_T = 0$ if and only if $\mu = 1/3(\sigma = 3/2)$. When $\mu < 1/3(\sigma < 3/2)$, $\delta_T > 0$ and there is point T for $0 \leq \delta < 1$. When $\mu > 1/3(\sigma > 3/2)$, $\delta_T < 0$ and there is not point T for $0 \leq \delta < 1$. Therefore, the shape of the WW curve can be as in Fig. 3, Fig. 4.

Thus, when the elasticity of substitution across varieties, σ, is grater than or equal to 3/2, the lower transportation costs (the larger δ) are, the smaller the disparities in wage and income between the countries are. On the other hand, when σ is less than 3/2, there is δ_T for $0 < \delta < 1$, where the disparities in wage and income are maximum. This can be explained by the following reasons. When the elasticity of substitution across varieties, σ, is large, the price competition among firms is severe. Therefore, firms intend to choose production locations where they can provide consumers with goods more cheaply. When transportation costs become lower, the share of firms located in the country with low wage increases because it becomes more profitable for firms to choose their production location in a country with low wage and export goods from there to another country. Then, since the demand for labor increases in the country with low wage, the wage disparity contracts as transportation costs decrease. On the other hand, when the elasticity of substitution across varieties is small, the price competition among firms is not very severe. If transportation costs are high enough, it is profitable for firms to provide goods at higher prices without paying transportation costs. Therefore, if transportation costs fall slightly, the share of firms located in the country with a large market increases, expanding the differential in wage between the countries. However, if transportation costs are low enough, the advantage of locating in a big market is small for firms while the disadvantage of high production costs is large. Therefore, the share of firms located in the large country declines lowering the wage there.

Now, when δ_T exists, there is the critical value of δ where a value of W is equal to that for δ=0. Let this point on the WW curve be point C. In the following part, variables corresponding to point C are accompanied by subscript C. Whether $0<\delta_C<1$ or not depends only on the value of σ (μ).

Next, we will confirm the magnitude of γ, ϕ and e according to any level of $\sigma(\mu)$ and $\phi_0 \geq 1/2$. First, we investigate the case in which $\mu<1/3$ and $\delta<\delta_C$ ($\tau>\tau_C$). Because $W<W_{\delta=0}=W_C$ for $0<\delta<\delta_C$, we obtain $\gamma>\gamma_C$ from Eq. (27). Taking into account that $\gamma_C=\phi_0$, we obtain

$$\gamma > \phi_0 \qquad (36)$$

for $0<\delta<\delta_C$. From Eq. (25), we obtain that $\partial e/\partial\gamma=\alpha\mu>0$. Considering Eqs. (28),(36) and $\alpha\mu<1$, we obtain

$$\gamma > \phi = e > \phi_0 \qquad (37)$$

Because the share of the North in assets demand, ϕ, is larger than the share of assets owned by the North, ϕ_0, the South exports ownership of assets to the North. Moreover foreign direct investment (FDI) takes place from the South into the North because the share of firms located in the North, γ, is higher than its share of demand for assets, ϕ. Moreover, because $\gamma>e$, the North is a net exporter of differentiated goods.

On the other hand, in the case where $\mu\geq 1/3$ or where $\mu<1/3$ with $\delta_C<\delta<1$ ($\tau<\tau_C$), we obtain

$$\gamma < \phi = e < \phi_0 . \qquad (38)$$

Contrary to the previous case, the South imports assets from the North besides the inflow of FDI from the North and becomes a net exporter of differentiated goods.

Before closing this section, we will investigate how the values of W_C and δ_C are related to that of μ (σ). From Eqs. (27), (28), (30) and the definition of point C, W_C and δ_C are expressed respectively as

$$W_C = \left(\frac{\phi_0}{1-\phi_0}\right)^{\frac{-\mu}{1-\mu}}, \tag{39}$$

$$\delta_C = \frac{-1+\phi_0\left(1+W_C{}^2\right)}{W_C\left(2\phi_0-1\right)}. \tag{40}$$

Taking into account that $W_C>\delta_C>0$ together with Eqs. (39) and (40), we obtain

$$\frac{\partial W_C}{\partial \mu} = \frac{-W_C}{(1-\mu)^2}\ln\frac{\phi_0}{1-\phi_0} < 0, \tag{41}$$

$$\frac{\partial \ln \delta_C}{\partial \mu} = \frac{-1}{(1-\mu)^2}\left[\frac{W_C 2\phi_0}{\delta_C\left(2\phi_0-1\right)}-1\right]\ln\frac{\phi_0}{1-\phi_0} < 0. \tag{42}$$

The larger μ (σ) is, the smaller W_C and δ_C are, and δ_C=0 when μ=0.

4. The Long-run Equilibrium

In the long-run, ϕ_0 changes in response to international flow of assets. In this section, we investigate the long-run equilibrium after we inquire into the effects of changes in the share of assets owned by the North, ϕ_0, on γ, W, e, and w. As in the previous section, we assume that $\phi_0>1/2$.

Totally differentiating Eqs. (26) and (27) with given μ and expressing them in a matrix form gives

$$\begin{bmatrix} \gamma - \dfrac{\alpha\mu\gamma W\left(1-\delta^2\right)}{(1-W\delta)(W-\delta)} & -\dfrac{\delta\left(W^2\gamma+1-\gamma\right)}{(1-W\delta)(W-\delta)} \\ \dfrac{\mu}{1-\mu}(1+w) & 1 \end{bmatrix}\begin{bmatrix} \dfrac{d\gamma}{\gamma} \\ \dfrac{dW}{W} \end{bmatrix} \tag{43}$$

$$= \begin{bmatrix} b_{11} d\delta + b_{12} d\phi_0 + b_{13} d\alpha \\ 0 \end{bmatrix},$$

$$b_{11} = \frac{W}{(1-W\delta)(W-\delta)} \left\{ \frac{e(W-\delta)}{1-W\delta} - \frac{(1-e)(1-W\delta)}{W-\delta} \right\},$$

$$b_{12} = \frac{(1-\alpha\mu)W(1-\delta^2)}{(1-W\delta)(W-\delta)},$$

$$b_{13} = \frac{\mu(\gamma-\phi_0)W(1-\delta^2)}{(1-W\delta)(W-\delta)}.$$

Label the matrix on the left-hand side of Eq. (43) J. From Eqs. (22), (25), (43) and $|J|>0$, we obtain follows:[9,10]

$$\frac{\partial\gamma/\gamma}{\partial\phi_0} > 0, \quad \frac{\partial W/W}{\partial\phi_0} < 0, \quad \frac{\partial w}{\partial\phi_0} > 0, \quad \frac{\partial e}{\partial\phi_0} > 0. \qquad (44)$$

For $0 \leq \delta < 1$, the higher the share of assets owned by the North is, the higher the share of firms located in the North gets, leading to a rise in the wage and a decline in W. Therefore, the larger ϕ_0 is, the lower the WW curve lies. As it is obvious from Eq. (29), the WW curve coincides with the graph of W=1 when ϕ_0=1/2.[11] Clearly form the definition of point C, point C does not exist if ϕ_0=1/2. If point C exists, that is, if ϕ_0>1/2 and μ<1/3, the smaller ϕ_0 is, the higher the critical value δ_C is.[12] We can find the limit of δ_C as ϕ_0 approaches 1/2 as follows:

$$\lim_{\phi_0 \to 1/2} \delta_C = \frac{1-3\mu}{1-\mu}. \qquad (45)$$

Therefore, $\delta_C < (1-3\mu)/(1-\mu)$. In the following part, we denote δ_C by δ_{Cj} when $\phi_0 = \phi_{0j}$.

Then, we investigate the equilibrium in the long-run when ϕ_0 changes in response to international flow of assets. Suppose that the share in initial assets owned by the North is ϕ_{01} and larger than 1/2, and transportation costs are δ_A. The long-run

[9] See Appendix 3.
[10] Considering Eq.(33), (43) and $|J|>0$, $(\partial\gamma/\gamma)/\partial\delta$ and $(\partial W/W)/\partial\delta$ have the same signs indicated in Fig.3 and Fig.4. See Appendix 4.
[11] See footnote 6.
[12] See Appendix 6.

equilibrium depends on the values of the elasticity of substitution across varieties, σ (μ), and transportation costs, τ (δ). Therefore, we will classify economy into the following three cases and investigate the long-run equilibrium: Case 1) $0<\delta_A<\delta_{C1}<(1-3\mu)/(1-\mu)$, Case 2) $0<\delta_{C1}<\delta_A<(1-3\mu)/(1-\mu)$, Case 3) $(1-3\mu)/(1-\mu)\leq\delta_A<1$. In Case 1 and Case 2, $\mu<1/3$ and point C exists. Case 3 applies when $\mu\geq 1/3$ and partly when $\mu<1/3$.

First, let us investigate Case 1. Because $\delta_A<\delta_C$ in Case 1, the initial short-run equilibrium is point A on the WW_1 curve (See Fig. 5.) where $\phi>\phi_{01}$ and $W_A<W_{C1}$. Because $\phi>\phi_{01}$ at point A, assets flow into the North. The increase in ϕ_0 shifts the WW curve downward gradually. Assets owned by the North continues to increase until ϕ is equal to ϕ_0 for δ_A, i.e. the short-run equilibrium is point C_2 on the WW_2 curve where $\delta_C=\delta_A$. Clearly from Eq. (44), the wage and income differentials at point C_2 are larger than those at point A.[13]

As we saw in the previous section, if the elasticity of substitution across varieties, σ, is small and the transportation costs (δ) are high (low), firms tend to choose production locations in the large country. Then, the wage and income disparities between the countries expand. Clearly from Eq. (37), the share of the North in expenditure exceeds the share of assets owed by North. Because the total expenditure of households is divided, at fixed rate, into assets holding and consumption of goods, the households of the North buy additional assets so as to equalize those two shares. Since there is the circular causality, that is, the disparity in assets possession induces the wage differential leading to a farther disparity in assets possession, the differential in capital possession between the countries expands cumulatively.

Next, we investigate Case 2 in which $\delta_A>\delta_C$. The initial short-run equilibrium is

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[13] See Appendix 6.

point A' on the WW curve. Because $\phi < \phi_{01}$ at point A', outflow of assets from the North shifts the WW curve upward. A decrease in capital owned by the North continues until ϕ is equal to ϕ_0 for $\delta_{A'}$, i.e. the short-run equilibrium is point C_2' on the WW_2' curve. The wage and income differentials between the countries decrease at point C_2' as compared with point A'.[14]

Next, we will investigate Case 3. Considering Eq. (45), $\delta_{A''} > \delta_C$ for any ϕ_0 that if $\mu < 1/3$ in which case point C exists. If $\mu \geq 1/3$, point C does not exist. Clearly from Eq. (38), $\phi < \phi_0$ for any ϕ_0 in both cases. Gradual capital outflow from the North shifts the WW curve upward until $\phi_0 = 1/2$, that is, the WW curve keeps moving until it coincides with the graph of $W=1$. In the long-run, the wage and income differentials and the disparity in assets possession are exhausted. (See Fig. 3.)[15]

In Case 2, the elasticity of substitution across varieties, σ, is small and the transportation costs (δ) are low (high) enough. The advantage of locating in a big market is small for firms. In Case 3, the elasticity of substitution across varieties, σ, is large and the price competition among firms is severe. Therefore it is disadvantageous for firms to produce in a country with high wage, and the share of firms located in the large country is not high in these cases. Clearly from Eq. (38), the share of the North in expenditure is smaller than the share of assets owed by North in both cases. The households of the North sell their assets so that the two shares are equal. Thus the differential in capital possession between countries contracts. The wage differential, that is, costs differential, remains in Case 2 in which the elasticity of substitution across varieties is small while the costs differential is exhausted in Case 3 in which the price competition among firms is severe.

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[14] See Appendix 6.

[15] See Appendix 6.

Thus, the wage and income differentials and the disparity in assets possession between the countries remain in the long-run when $\delta<(1-3\mu)/(1-\mu)$. If $\delta<\delta_C$ ($\tau>\tau_C$), the disparities between the countries expand in the long-run while such disparities decrease but never be exhausted if $\delta>\delta_C$ ($\tau<\tau_C$). On the other hand, if $\delta<(1-3\mu)/(1-\mu)$, the disparities between countries are exhausted for any μ. The comparison among the three cases is shown in Table 1.

As just described, the degree of disparity in assets possession in the long-run depends on the elasticity of substitution across varieties and the transportation costs but it does not depend on a propensity to saving, $1-\alpha$. From Eqs. (36) and (43), we obtain

$$\frac{\partial W/W}{\partial \alpha} \mathop{\gtrless} 0 \Leftrightarrow \delta \mathop{\gtrless} \delta_C, \qquad \frac{\partial \gamma/\gamma}{\partial \alpha} \mathop{\lessgtr} 0 \Leftrightarrow \delta \mathop{\gtrless} \delta_C. \qquad (46)$$

When $\mu<1/3$, the bigger the propensity to consume, α, is, the more deeply the J-shape gets curved centered around $\delta=\delta_C$. The level of the propensity to consumption, α, does not affect the critical value δ_C but does affect the extent of disparity in assets possession when such disparity remains in the long-run. The long-run disparity in assets holding expands when $\delta<\delta_C$, and it contracts when $\delta_C<\delta<(1-3\mu)/(1-\mu)$.

5. Conclusion

In this paper, we constructed a two-factor, two-country model with transportation costs and showed that the disparity in assets possession between the countries brings about the wage and income differentials. Moreover, assets concentrate in a rich country in the long-run under some circumstances due to the circular causality.

The main findings in this paper are as follows. First, in the short-run with given assets possession, the share of firms located in the North which owes larger assets is more than 1/2. The wage in the North is higher than in the South whose assets are smaller. Therefore, the income differential between them becomes greater than the income differential induced by capital income. When the elasticity of substitution across varieties, σ, is grater than or equal to 3/2, the lower transportation costs are, the smaller the disparities in wage and income between countries are. On the other hand, when σ is less than 3/2, there is the transportation cost ($\delta_T\,(0<\delta_T<1)$) which maximizes the income and wage differentials.

Whether or not the disparity in assets possession between the countries persists in the long-run depends on the value of transportation costs τ (δ) and the elasticity of substitution across varieties, that is the price elasticity of demand for variety, $\sigma(\mu)$. If $\mu<1/3$ and $0<\delta<(1-3\mu)/(1-\mu)$, there is the critical value δ_C (τ_C) where a value of W is equal to that for $\delta=0$. When δ is smaller (higher) than the critical value, δ_C (τ_C), the disparities in assets possession, wage and income expand in the long-run. When δ (transportation costs) is larger (lower) than the critical value, δ_C (τ_C), the disparity in assets possessions as well as the disparities in wage and income contracts in the long-run. On the other hand, if $\delta\geq(1-3\mu)/(1-\mu)$, the wage and income differentials and the disparity in assets are exhausted for any μ ($0<\mu<1$). When $\mu<1/3$, the level of the propensity to consumption, α, affects the levels of the differentials in wage, income and the share of firms in the long-run for $0<\delta<(1-3\mu)/(1-\mu)$. The larger α gets, the more the long-run differentials expand when the transportation costs exceeds the critical value while the differentials contract in the long-run when the transportation costs are below the critical value.

Taking better advantage of lower labor costs than developed countries, NIEs which have successfully taken off are now producing competitive goods, that are highly substitutable with the goods produced by developed countries. In such a case, the wage and assets possession differentials between developed countries and NIEs will be reduced. However, LDCs, whose industrial bases are still weak, cannot fully compete with developed countries in the same industries solely by taking advantage of lower labor costs. Thus, the goods produced in LDCs are hardly substitutable with the ones produced in developed countries. As a result, chances are high for the disparities in wage and assets possession between developed countries and LDCs to expand.

As we have shown in this paper, the disparity in assets possession between a developing country and a developed country is exhausted in the long-run when the elasticity of substitution across varieties is grater than or equal to 1.5. Here, the elasticity of substitution across varieties is the same as the price elasticity of demand for variety. The price elasticity of the aggregated import demand in our model is obtained from Eqs. (5) and (6):

$$\sigma-(\sigma-1)\frac{k_S\delta}{k_N W+k_S\delta}$$

The larger σ is, the larger the price elasticity of the aggregated import demand is. Taking into consideration that $k_S\delta/(k_N W+k_S\delta)<1/2$, the possible minimum value of the aggregated import demand for $\sigma=1.5$ is 1.25. According to Senhadji (1998), the price elasticity of the aggregated import demand will never exceed 1.25 in any country. These estimations suggest a possibility that less developed countries remain underdeveloped due to their low assets possessions. However, if transportation costs fall below the level of the critical value, the current accounts of less developed countries will become surplus enabling them to accumulate assets. Significant progress in transportation technology benefits less developed countries. However, if a sufficient reduction in transportation costs is not expected, less developed countries cannot find the way out of underdevelopment without receiving income transfers from advanced countries.

In this paper, we assumed the trade costs as transportation costs. However, if trade costs arise mainly from tariff rather than transportation costs, we can derive the following implication on the trade policy of less developed countries. If the elasticity of substitution across varieties is smaller than 3/2, protection of domestic industries by resorting to trade barriers such as high tariffs will lead to reduction in the share of firms in the country. As a result, the country is more likely to be trapped in underdevelopment due to low savings induced by low income. If each country lowers tariff rate to achieve higher level of trade liberalization, developing countries become more attractive as production bases for firms. Then, the wage and income differentials and the assets disparity between developed countries and developing countries have better chances to narrow or disappear. In other words, if the world moves towards protectionism, the income and assets differentials between the developed countries and the developing countries will be expanded.

In order for low LDCs to break away from the trap of underdevelopment, realization of free trade on a global scale is desirable together with sufficient assistance from advanced countries.

Appendix 1

Let us assume that the household has a myopic expectation towards firm profits and expects that profits in all the future periods are equal to that in this period. Then, the value of stock on the market which is the present discount value of all the future profits is expressed as:

$$\frac{\pi}{1+r}+\frac{\pi}{(1+r)^2}+\frac{\pi}{(1+r)^3}+\cdots. \qquad \text{(A1)}$$

Eq. (A1) expresses the infinite geometric series of which first term is $\pi/(1+r)$ and common ratio is $1/(1+r)$. Therefore, we can rewrite Eq. (A1) as

$$\frac{\pi}{1+r}\left[\frac{1}{1-1/(1+r)}\right]=\frac{\pi}{1+r}\left[\frac{1+r}{1+r-1}\right]=\frac{\pi}{r}$$

Appendix 2

From Eqs. (10) and (2), we obtain Eq. (12). Using Eqs. (7) and (8) yields the market clearing condition in each variety as follows:

$$x_N=\alpha L\left[P_N{}^{\sigma-1}p_N{}^{-\sigma}E_N+\tau^{1-\sigma}P_S{}^{\sigma-1}p_N{}^{-\sigma}E_S\right], \qquad \text{(A2)}$$

$$x_S=\alpha L\left[\tau^{1-\sigma}P_N{}^{\sigma-1}p_S{}^{-\sigma}E_N+P_S{}^{\sigma-1}p_S{}^{-\sigma}E_S\right]. \qquad \text{(A3)}$$

By substituting Eqs. (10) and (12) into Eqs. (A2) and (A3), we have Eqs. (13) and (14). Moreover, since profits in both countries are equal, we obtain Eq. (A4) from Eq. (11)

$$x_S=x_N w. \qquad \text{(A4)}$$

Substituting Eqs. (13) and (14) into Eq. (A4) gives

$$\frac{E_N(W-\delta)}{k_N W+k_S\delta}=\frac{E_S(1-W\delta)}{k_N\delta W+k_S}. \qquad \text{(A5)}$$

Using k_S=$K-k_N$ with Eq. (A5), we obtain

$$E_N(W-\delta)[k_N W\delta+k_S]=E_S(1-W\delta)[k_N W+k_S\delta]$$

and then

$$k_N\left[E_N(1-W\delta)(W-\delta)+E_S(W-\delta)(1-W\delta)\right]=K\left[E_N(W-\delta)-E_S(1-W\delta)\delta\right].$$

Therefore, we obtain $\gamma = k_N/K$ as Eq. (16).

Using Eq. (16), we obtain the denominators of Eq. (A5) as follows:

$$k_N W + k_S \delta = \frac{K}{(1-W\delta)(W-\delta)[E_N + E_S]}$$

$$\times [W\{E_S(W-\delta) - E_N(1-W\delta)\delta\} + W\delta\{E_N(1-W\delta) - E_S(W-\delta)\delta\}]$$

$$= \frac{KWE_N(W-\delta)(1-\delta^2)}{(1-W\delta)(W-\delta)[E_N + E_S]}$$

$$= \frac{KWE_N(1-\delta^2)}{(1-W\delta)[E_N + E_S]} \qquad \text{(A6)}$$

$$k_N W\delta + k_S = \frac{K}{(1-W\delta)(W-\delta)[E_N + E_S]}$$

$$\times [W\delta\{E_N(W-\delta) - E_S(1-W\delta)\delta\} + W\{E_S(1-W\delta) - E_N(1-W\delta)\delta\}]$$

$$= \frac{KWE_S(1-W\delta)(1-\delta^2)}{(1-W\delta)(W-\delta)[E_N + E_S]}$$

$$= \frac{KWE_S(1-\delta^2)}{(W-\delta)[E_N + E_S]} \qquad \text{(A7)}$$

By substituting Eqs. (A6) and (A7) into Eq. (14), we obtain Eq. (17) as follows:

$$x_S = \frac{\alpha L(\sigma-1)[E_N + E_S]}{\sigma\beta KW(1-\delta^2)}\left[\frac{\delta E_N(1-W\delta)}{E_N} + \frac{E_S(W-\delta)}{E_S}\right]$$

$$= \frac{\alpha L(\sigma-1)[E_N + E_S]}{\sigma\beta KW(1-\delta^2)}[\delta - W\delta^2 + W - \delta]$$

$$= \frac{\alpha L(\sigma-1)[E_N + E_S]}{\sigma\beta K}$$

$$= \frac{\alpha L\mu[E_N + E_S]}{\beta K}. \qquad (17)$$

Moreover, substituting Eq. (17) into Eq. (11) yields the profits in equilibrium as Eq. (18).

Appendix 3

Using Eq.(25), we can rewrite Eq (26) as

$$\gamma = \frac{(1-\alpha\mu)\phi_0 W(1-\delta^2) - \delta(1-W\delta)}{(1-W\delta)(W-\delta) - \alpha\mu W + \alpha\mu W\delta^2}. \qquad \text{(A8)}$$

Setting δ=0in Eq. (A8), we obtain

$$\gamma = \frac{(1-\alpha\mu)\phi_0 W}{(1-\alpha\mu)W} = \phi_0. \qquad \text{(A9)}$$

The numerator and the denominator of Eq. (A9) are both positive. Considering Eq. (30) and the fact that γ is continuous for $0<\delta<1$, the denominator of Eq. (A9) is positive for $0<\delta<1$:

$$(1-W\delta)(W-\delta) - \alpha\mu W(1-\delta^2) > 0, \quad \text{for} \quad 0 \leq \delta < 1. \qquad \text{(A10)}$$

By the way, the determinant of J, $|J|$, in Eq. (43) is expressed as

$$\left[(1-W\delta)(W-\delta)\gamma - \alpha\mu\gamma W(1-\delta^2) + \frac{\mu\delta(1+w)(W^2\gamma+1-\gamma)}{1-\mu}\right] \Big/ (1-W\delta)(W-\delta)$$

If the form of *WW* curve is as shown in Fig. 2 , $\partial W/\partial\delta=\infty$ at δ_{R1} and $\delta_{R2}$where the *WW* curve is vertical, that is, $|J|=0$. However, taking into consideration expression (A10), $|J|>0$ for $0 \leq \delta < 1$. Thus, the *WW* curve does not have vertical segments.

Appendix 4

From Eq. (31), we obtain Eq. (A11) at point T:

$$\delta_T = \frac{-1+\gamma_T(1+W_T{}^2)}{2[\gamma_T-(1-e_T)]W_T}, \qquad \text{(A11)}$$

$$\left[\gamma_T W_T{}^2 - (1-\gamma_T)\right] / W_T = -2\delta_T(1-\gamma_T-e),$$

$$W_T\gamma_T - \frac{1-\gamma_T}{W_T} = -2\delta_T\left[\frac{W_T(1-e_T)}{W_T-\delta_T} - \frac{e_T}{1-W_T\delta_T}\right],$$

$$W_T\left[\gamma_T + \frac{2\delta_T(1-e_T)}{W_T-\delta_T}\right] - \left[\frac{1-\gamma_T}{W_T} + \frac{2\delta_T e_T}{1-W_T\delta_T}\right] = 0,$$

$$W_T\left[\frac{e_T}{1-W_T\delta_T} + \frac{\delta_T(1-e_T)}{W_T-\delta_T}\right] - \left[\frac{1-e_T}{W_T-\delta_T} + \frac{\delta_T e_T}{1-W_T\delta_T}\right] = 0.$$

Therefore, we obtain Eq. (33):

$$\frac{e_T(W_T-\delta_T)}{1-W_T\delta_T} - \frac{(1-e_T)(1-W_T\delta_T)}{W_T-\delta_T} = 0. \qquad (33)$$

Appendix 5

The relations among e, W, and δ expressed by Eq.(33) exist at point T. The expression on the left-hand side of expression (33) is equal to the inside of the brace in b_{11} on the right-hand side of Eq. (43). Therefore, the sign of the term for $d\delta$ changes at $\delta=\delta_T$. If $\mu<1/3$, the inside of the brace for $\delta=0$ is equal to

$$\frac{(1-\phi_0)}{W}\left[\left(\frac{\phi_0}{1-\phi_0}\right)^{\frac{1-3\mu}{1-\mu}} - 1\right]. \qquad (A12)$$

The sign of expression (A12) is positive. Therefore, the inside of expression (A12) is positive when $\delta<\delta_T$, and negative for $\delta>\delta_T$. Since $|J|>0$, we obtain the followings from Eq. (43):

$$\frac{\partial W/W}{\partial\delta} \underset{<}{\overset{>}{-}} 0 \Leftrightarrow \delta \underset{<}{\overset{>}{-}} \delta_T, \qquad \frac{\partial\gamma/\gamma}{\partial\delta} \underset{<}{\overset{>}{-}} 0 \Leftrightarrow \delta \underset{>}{\overset{<}{-}} \delta_T.$$

If $\mu>1/3$, point T does not exist for $0\leq\delta<1$. Therefore, the sign of $(dW/W)/d\delta$ is equal to that for $\delta=0$. Because the sign of (A12) is negative for $\delta=0$, we obtain the same results indicated in Fig.3 and Fig.4:

Appendix 6

Suppose that the initial share of assets owed by the North is $\phi_{01}>1/2$, $\mu<1/3$ and transportation costs are $\delta_A<\delta_{C1}$. The initial short-run equilibrium is point A on the WW_1 curve (See Fig.5.) where $\phi>\phi_{01}$, $W_A<W_{C1}$ and also we can find $\delta_A<W_A$ from expression (30). Because $\phi>\phi_{01}$ at point A, assets flow into the North and ϕ_0 increases gradually. From expression (44), the WW curve shifts downward and W_A decreases. As it is clear form Eq. (39), W_C gradually decreases. Now we assume that W_A decreases faster than W_C which results in W_A never being equal to W_C. Because $W_A<W_C$, the inflow of assets into the North and increase in ϕ_0 continue. Consequently, W_C continues to decrease to be $W_C<\delta_A$. Because, $W_A<W_C$ by assumption, we obtain that $W_A<W_C<\delta_A$ which contradicts expression (30). Therefore, W_A is equal to W_C, i.e. $\delta_A=\delta_C$ ($<\delta_{C1}$) for a certain ϕ_{02}. This holds for any $\delta<\delta_{Cj}$ with every initial $\phi_{0j}>1/2$. Taking into consideration the above result, Eq. (45) and the fact that each ϕ_{0j} has only one δ_{Cj}, any δ is δ_{Cj} for $\delta<(1-3\mu)/(1-\mu)$. If $\delta_{C1}>\delta_{C2}$, $\phi_{01}<\phi_{02}$. On the other hand, any δ is not δ_{Cj} for $\delta>(1-3\mu)/(1-\mu)$.

From the above argument, in Case 1, the inflow of assets to the North increases ϕ_0 until $\delta_A=\delta_C$. In Case 2, the outflows of assets from the North ends at a certain ϕ_0. In Case 3, $\delta>(1-3\mu)/(1-\mu)$. Because there exist no $\phi_0>1/2$ that makes $\delta=\delta_C$, the outflows of assets from the North continues until $\phi_0=1/2$.

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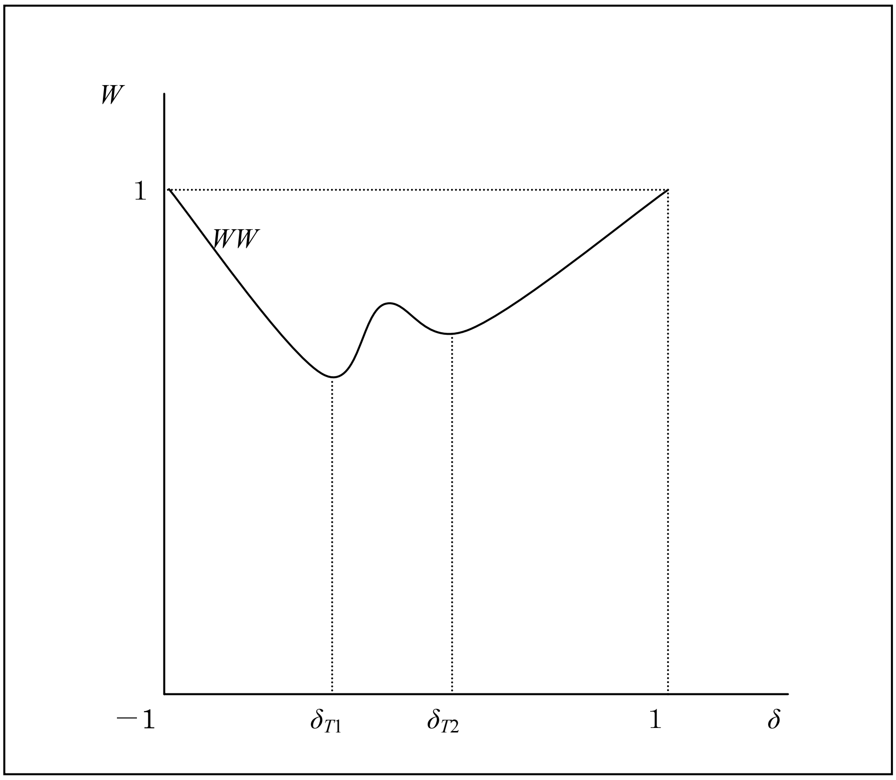

Figure 1

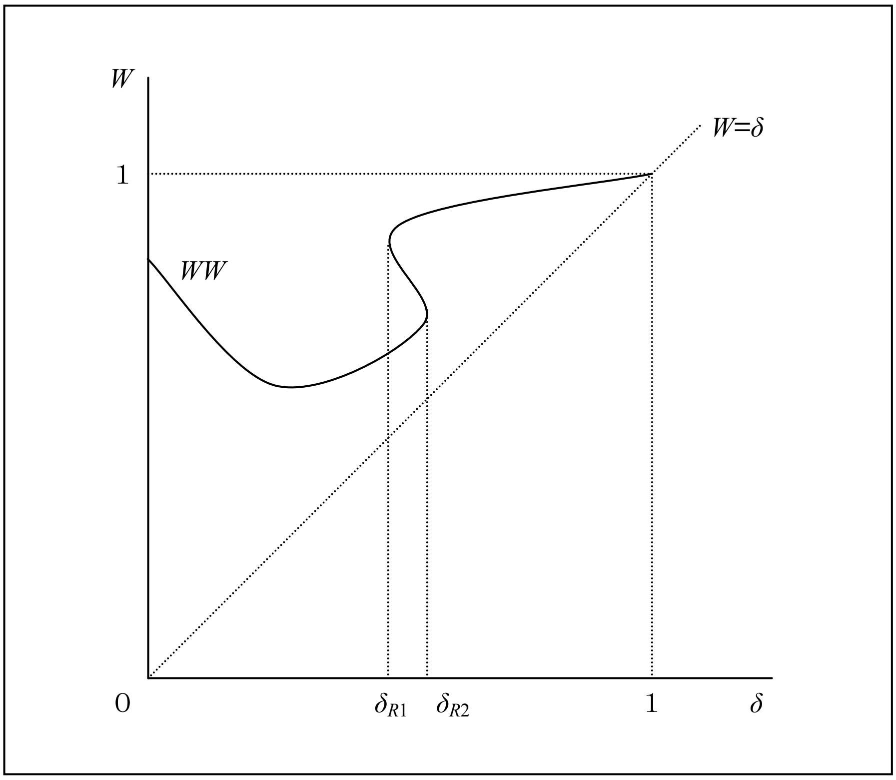

Figure 2

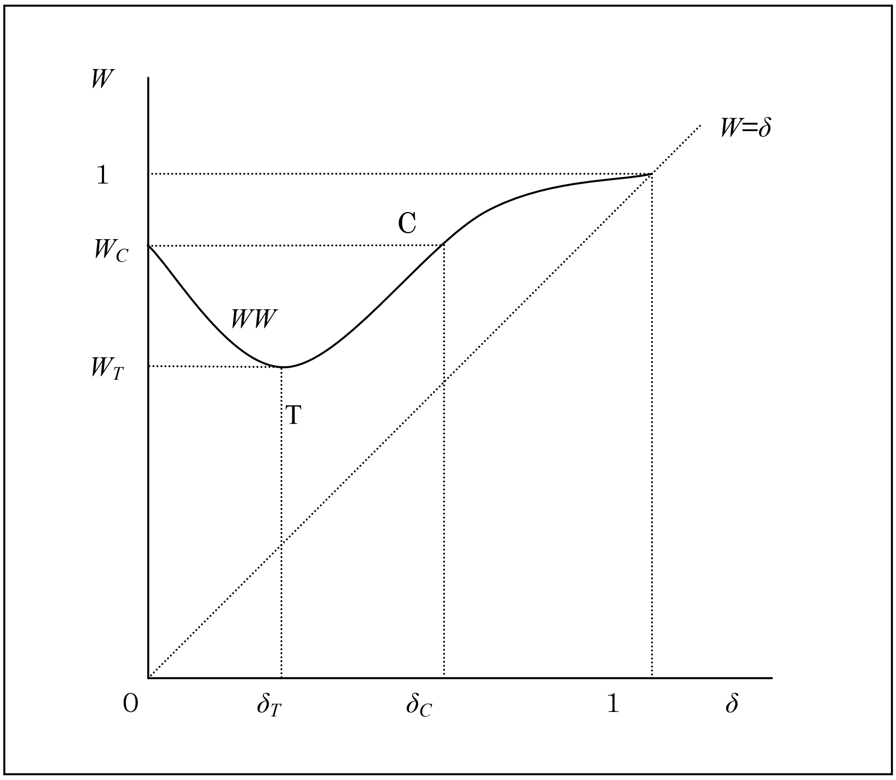

Figure 3 $\sigma<3/2(\mu<1/3)$

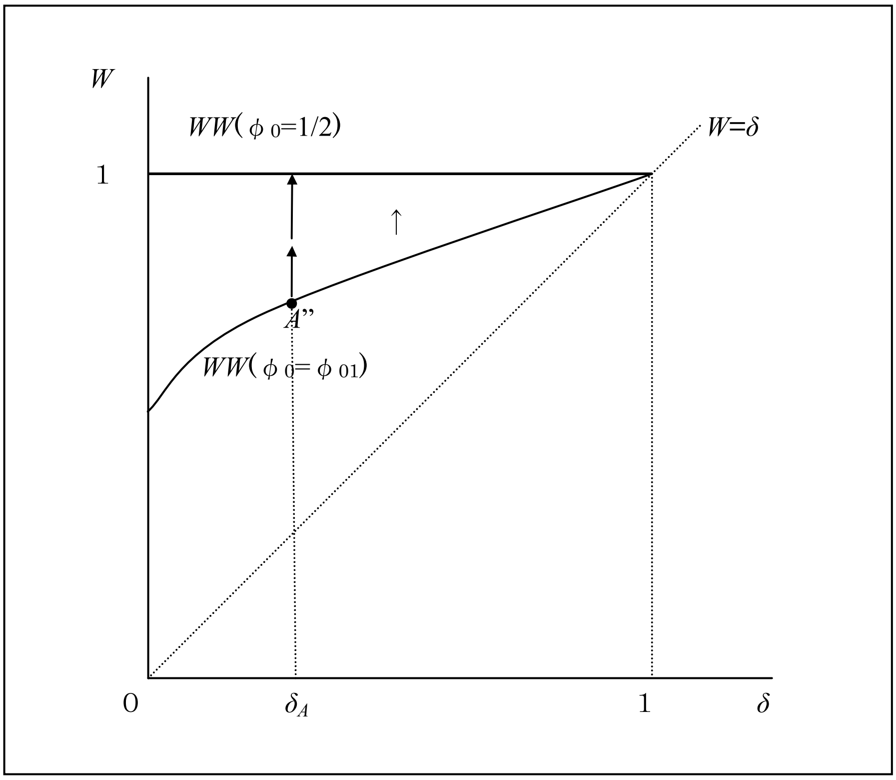

Figure 4 $\sigma \geq 3/2 (\mu \geq 1/3)$

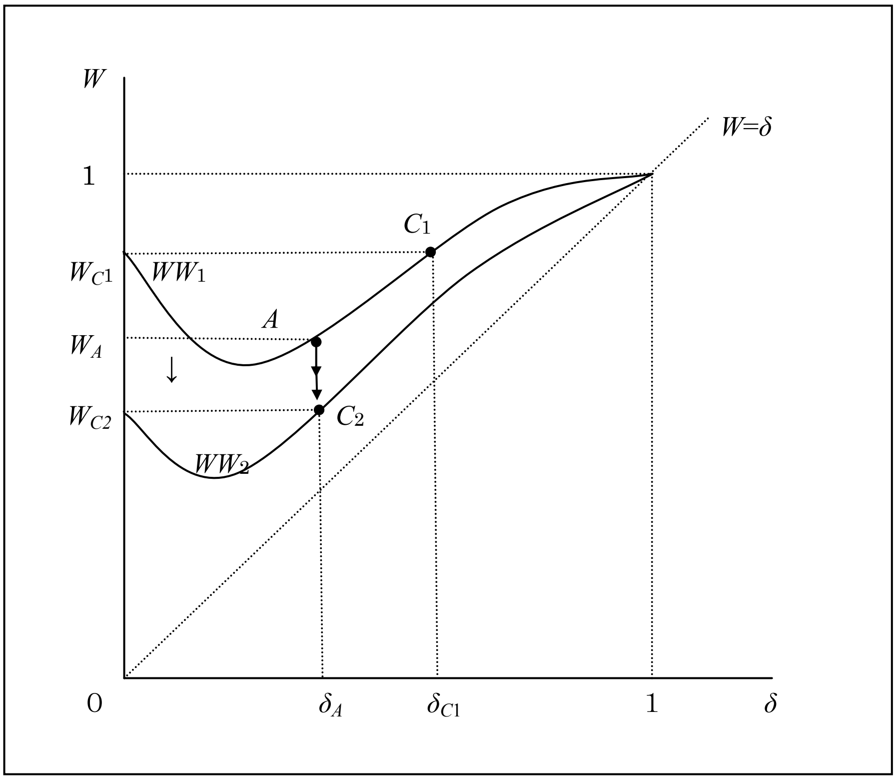

Figure 5 Case 1

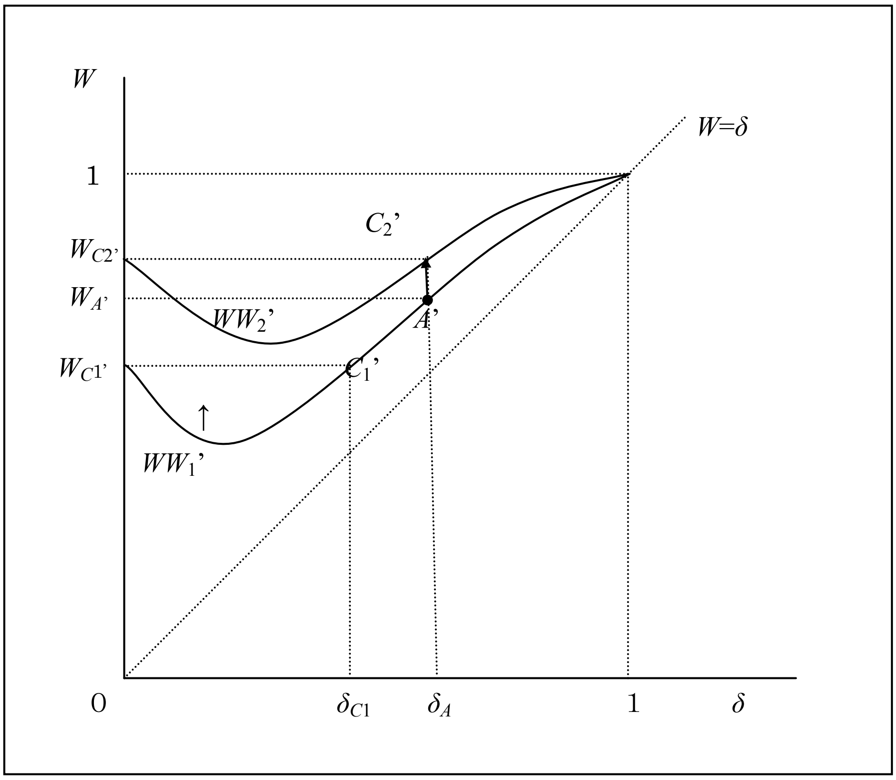

Figure 6 Case 2

	$0 \leq \delta < \delta_C$	$\delta = \delta_C$	$\delta_C < \delta < 1$
$\sigma < 3/2$ ($\mu < 1/3$)	Disparity in capital between countries remains		
	Expand	Not change	Contract
$\sigma \geq 3/2$ ($\mu > 1/3$)	Disparity in capital between countries is exhausted		

Table 1