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Abstract

The role played by the economic activity of each developed and developing country is becoming increasingly important with the advancement of economic globalization. Most importantly, it helps in revealing the economic structure that new products are innovated in the developed countries and then they are imitated in developing countries. This article aims to discuss the extent to which these activities affect the economic welfare of two counties, namely, the North and South.

An analysis of this article leads to the following conclusions: (1) with the expansion of the labor market in the South, there is a definite increase in the welfare of the North, but, there is no change in the welfare of the South, and (2) with the growth in the rate of innovation, there is a definite increase in the welfare of the South, but, the welfare of the North cannot be ascertained.

【Key words】 Intellectual Property Rights, Innovation and Imitation,
JEL classification; D60, F10, O34

I Introduction

As the globalization of the contemporary world advances, the structure of production becomes increasingly diversified. This implies the vertical international specialization of production in the developed and developing countries, the horizontal division of production among the developed countries, and production by foreign direct investment and so on. Although the structure of production may be increasingly complex, the fact remains that the new products are invented in a place other than the one in which they are imitated. Therefore, it is important to analyze both the innovation of production and the imitation of the products.

In his "product cycle model," Raymond Vernon (1966) suggested that many products undergo various stages in their production. These products are initially discovered and

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produced in the developed country (the North). Thereafter, they are exported to the developing country (the South). With the standardization of the techniques of production, production shifts to the developing country, where the labor costs are lower. Further, this idea was constructed as a mathematical model in Krugman (1979). In his paper, Krugman (1979) showed the structure of the "product-cycle" existent in the North and South. The main feature of his model is that both the rate of innovation and the rate of imitation are exogenous variables. Further, he assumed that a new technology that was innovated in the North gradually permeated into the South. Thus, the North has an edge of technological innovation over the South. On the other hand, the South has the advantage of lower cost. These features of the model have been incorporated in many studies that were conducted later.

Helpman (1993) was influenced by Krugman (1979). Helpman's paper examines the debate between the North and South with regard to the enforcement of intellectual property rights (IPRs) within a dynamic general equilibrium framework in which the North invents new products and the South imitates them. In the first section, Helpman discusses how the regulation of IPRs affects the welfare of the North and South, when the rate of innovation and the rate of imitation are considered as exogenous variables. In the next section, he constructs the model in which the rate of innovation is considered as an endogenous variable. In the last section, he constructs the model that includes foreign direct investment.

This paper is based on the model that was constructed in the first section of Helpman (1993); thus, we will consider the rate of innovation and the rate of imitation as exogenous variables. And, I would like to describe the feature of this paper. First, we will discuss how an increase in the rate of innovation or the expansion of the labor market in the South affects the welfare of the North and South. This point has not been discussed in Helpman (1993). Second, we assume that the Northern government can control the rate of imitation in order to maximize the welfare of the North.

Before proceeding to the next section, we will present an outline of our model. Only the developed country (the North) can innovate new products and produce them, and the North can control imitation activity of the South in order to maximize its welfare. On the other hand, the developing country (the South) is engaged in producing elderly production that it has succeeded in imitating. Therefore, the North has a monopolistic power with regard to the supply of its products until the South succeeds in imitating them. Once the South succeeds in imitating the products of the North, these products will not be produced in the North again. This is based on our assumption that the labor costs of the South are lower than those of the North.

In following section, we will construct a basic model, and in sectionⅢ, we will investigate the effect of the rate of imitation on the welfare of both the countries. In sectionⅣ, we will discuss how the growth in the rate of innovation or the expansion of the labor market in the South affects the welfare of the North and South.

II Basic Model

1 The Model

In this economy, there are two countries: the North (developed country) and the South (developing country). The new products are invented and produced in the North, and are later imitated by the competitive firms in the South.

As discussed, the new products are discovered at a constant exogenous rate (g) and are imitated at a constant exogenous rate (m). We denote the number of producible goods as n, the number of goods that have been imitated by the South as n^S, and the number of unimitated goods as n^N. Thus, we can obtain

(1) $n^S + n^N = n.$

We can show the number of available goods at time *t* in this economy, and let ζ be the fraction of unimitated products,

(2) $n_{(t)} = n_{(0)} e^{gt}$ and

(3) $\zeta = n^N / n.$

The South imitates the products manufactured in the North at a constant exogenous rate,

(4) $m = \dot{n}^S / n^N$.

The rate of imitation represents the fraction of products being imitated per unit time.

The household has identical preferences in both the regions and behaves to maximize the lifetime utility. Their welfare is equal to the discounted flow of utility,

(5) $U_{(t)} = \int_t^{\infty} e^{-\rho(\tau - t)} \ln u_{(\tau)} d\tau$,

where $\rho > 0$ represents the subjective discount rate, and $\ln u_{(\tau)}$ is an instantaneous utility at time τ .

The instantaneous utility depends on consumption,

(6) $u = \left[n^N \left(x^N \right)^{\alpha} + n^S \left(x^S \right)^{\alpha} \right]^{1/\alpha} \quad \alpha \in (0,1)$,

where x^N, x^S represents the consumption of products n^N and n^S, respectively. These

preferences are homothetic. The utility of a representative consumer depends not only on the quantity of the consumption but also on the variety of consumption.

The representative consumer maximizes his/her utility function, subject to budget constraints,

(7) $E = n^N x^N p^N + n^S x^S p^S$,

where E represents the aggregate spending on consumer products and p^N (p^S) represents the price of the product manufactured in the North (South).

Therefore, the aggregate demand can be directly derived from individual preferences.

(8) $x^i = (p^i)^{-\varepsilon} \frac{E}{P^{1-\varepsilon}}$, $i = N, S$ and

$$\varepsilon = \frac{1}{1-\alpha} > 1, P = \left[n^N (p^N)^{1-\varepsilon} + n^S (p^S)^{1-\varepsilon} \right]^{1/1-\varepsilon},$$

where ε denotes the constant elasticity of demand, and P denotes a price index.

Consider labor to be the only factor of production and the labor force in both the regions to be equally productive. This labor force is not interregionally mobile. Constant returns to scale prevail in production, with one unit of labor producing one unit of product.

It is assumed that a manufacturer inventing a product in the North can charge a monopoly price as long as his or her product has not been imitated. Therefore, it can be shown that the monopoly price of every unimitated product is equal to

(9) $p^N = \frac{1}{\alpha} w^N$,

where w^N represents the wage rate in the North, which is equal to the marginal cost incurred by the manufacturer in the North[3]. Thus, the manufacturer can price his or her products above their marginal cost as long as the products are not imitated by a manufacturer in the South. Once the products are imitated by a manufacturer in the South, competition leads to marginal cost pricing for the remaining n^S products.

(10) $p^S = w^S$,

where w^S represents the wage rate in the South and denotes the marginal cost incurred by the manufacturer in the South.

It is assumed that the wage rate in the North is higher than that in the South. This assumption suggests that products are innovated and produced in the North and are

[3] It follows that the n^N products that have not been imitated are priced at a markup above the wages in the North.

imitated in the South. The wage rate in the South is assumed to be normalized to one,

(11) $w^S = 1$.

Let L^N and L^S be the aggregate endowments of labor in the North and South, respectively. These labor endowments remain constant over time. As mentioned earlier, x^N, x^S represents the consumption of each product, which also implies the production of each product. Therefore, the labor market clearing conditions can be shown by

(12) $n^i x^i = L^i, i = N, S$.

Based on demand functions and labor market conditions, the equation of the relative prices between both the products is obtained as follows:

(13) $$\frac{p^N}{p^S} = \left[\gamma \cdot \frac{\zeta}{1-\zeta} \right]^{1/\varepsilon}, \quad \gamma \equiv \frac{L^S}{L^N}.$$

This equation reveals that shifts in the interregional distribution of manufacturing affect relative prices. An increase in the fraction of unimitated products improves the terms of trade in the North, but leads to a deterioration of the terms of trade in the South. With the given labor endowments, an increase in the fraction of such products reduces the quantity of each product in the North. In this way, the price of the products produced in the North becomes higher.

In addition, the expansion of the labor market in the South improves the terms of trade in the North, but leads to a deterioration of the same in the South. With the given fraction of unimitated products, the expansion of it increases the quantity of each product in the South. In this way, the price of the products produced in the South becomes lower.

The model in this section has now been completely described. It comprises the following 11 endogenous variables: n^N, n^S, n, ζ, p^N, p^S, w^N, w^S, x^N, x^S, and E. The following are the equations that determine these variables: (1), (2), (3), (4), (8), (9), (10), (11), and (12).

2 Steady State and IPRs

The growth rate of new products in the North, the rate of imitation, and the fraction of unimitated products are used to obtain the differential equation for the fraction of unimitated products,

(14) $\dot{\zeta} = g - (g + m)\zeta$.

The long-run steady state value and solution of this differential equation are

(15) $\overline{\zeta} = g/(g + m)$ and

(16) $\zeta_{(t)} = \bar{\zeta} + \left[\zeta_{(0)} - \bar{\zeta}\right] e^{-(g+m)t}$, respectively.

Like Helpman (1993), this article also interprets a tightening of IPRs as causing a decline in the rate of imitation[4]. Let μ be the degree of tightening of IPRs; thus, we can represent the rate of imitation as $m = \tilde{m} - \mu$, in which the initial value of μ is equal to zero. From (16), we can obtain the mechanism through which a tightening of IPRs affects the fraction of unimitated products.

(17) $\dfrac{d\zeta_{(t)}}{d\mu} = \left[1 - e^{-(g+m)t}\right]\dfrac{d\bar{\zeta}}{d\mu} + \left[\zeta_{(0)} - \bar{\zeta}\right] t e^{-(g+m)t}$, $\dfrac{d\bar{\zeta}}{d\mu} = \dfrac{g}{(g+m)^2} > 0$.

When the economy begins in a steady state ($\zeta_{(0)} = \bar{\zeta}$), the second term on the right-hand side is equal to zero. In this case, the fraction of unimitated products increases at each point in time, in response to a tightening of IPRs (except when $t = 0$). Since the total number of products available remains constant, it follows that the fraction of unimitated products increases due to a tightening of IPRs.

3 Terms of Trade and Interregional Allocation of Manufacturing

The terms of trade and the interregional allocation of manufacturing are described as important components. First, (6) and (8) help us to derive indirect utility functions of an individual consumer.

(18) $\ln u^i = \ln E^i - \ln P$, $i = N, S$.

This equation reveals that a consumer's instantaneous utility is equal to the logarithm of real spending. Next, a price index that has been formulated is shown as follows:

(19) $P = n^{1/1-\varepsilon}\left[\zeta (p^N)^{1-\varepsilon} + (1-\zeta)(p^S)^{1-\varepsilon}\right]^{1/1-\varepsilon}$.

The substitution of this equation into (18) can provide the instantaneous utility function in both the regions[5],

(20-a) $\ln u^N = \dfrac{1}{\varepsilon - 1}\ln n + \dfrac{1}{\varepsilon - 1}\ln\left[\zeta + (1-\zeta)(p^N / p^S)^{\varepsilon - 1}\right]$ and

(20-b) $\ln u^S = \dfrac{1}{\varepsilon - 1}\ln n + \dfrac{1}{\varepsilon - 1}\ln\left[\zeta (p^S / p^N)^{\varepsilon - 1} + (1-\zeta)\right]$.

These equations help us to understand the welfare effects caused by the relaxation of IPRs, which is represented as the decrease in the fraction of unimitated products. A relaxation of IPRs reduces the price index, leading to an increase in real income. This

[4] For example, the stronger legal and administrative actions undertaken by the Southern government are true instances of the tightening of IPRs (see Helman (1993)).

welfare effect will be referred to as “interregional allocation of manufacturing”.

On the other hand, the relaxation of it also results in the deterioration of the relative prices in the North and their improvement in the South; therefore, it negatively affects the Northern residents, but positively affects the Southern residents. We will refer to these welfare effects as “the terms of trade”.

Therefore, in the South, the relaxation of IPRs necessarily improves the welfare through these two channels of effects. However, in the North, the welfare is dependent on the degree of the two channels of effects; we can't ascertain the welfare effects. So, it is important to analyze this issue more carefully.

III Change in the Rate of Imitation and Welfare

1 Welfare of the North and South

The substitution of (2) and (20) into (5) yields the discounted flow of utility[6]. If the economy is in time zero ($t = 0$) and begins in a steady state,

(21-a) $$U_{(0)}^{N} = \frac{1}{\rho(\varepsilon - 1)}\left\{\frac{g}{\rho} + \ln n_{(0)} + \ln\{\bar{\zeta} + (1-\bar{\zeta})(p^{N}/p^{S})^{\varepsilon-1}\}\right\}$$ and

(21-b) $$U_{(0)}^{S} = \frac{1}{\rho(\varepsilon - 1)}\left\{\frac{g}{\rho} + \ln n_{(0)} + \ln\{\bar{\zeta}(p^{S}/p^{N})^{\varepsilon-1} + (1-\bar{\zeta})\}\right\}.$$

2 Change in the Rate of Imitation and the Welfare of the North

The substitution of (13) into (21-a) and the differentiation with respect to m results in

(22) $$\frac{dU_{(0)}^{N}}{dm} = \frac{1}{\rho(\varepsilon-1)}\left[\bar{\zeta} + (1-\bar{\zeta})\left(\gamma\cdot\frac{\bar{\zeta}}{1-\bar{\zeta}}\right)^{\alpha}\right]^{-1}\left\{1-\left(\gamma\cdot\frac{\bar{\zeta}}{1-\bar{\zeta}}\right)^{\alpha}\left(1-\frac{\alpha}{\bar{\zeta}}\right)\right\}\left\{\frac{-g}{(g+m)^{2}}\right\}.$$

As shown in (22), to decide the overall effect on the welfare of the North from the above equation is complicated. Therefore, in order to calculate the overall effect on the welfare of the North, this equation is simplified by substituting (15) into (22) as follows:

(23) $$\frac{dU_{(0)}^{N}}{dm} \gtreqless 0 \quad \Leftrightarrow \quad \left(\frac{m}{g\gamma}\right)^{\alpha} \lesseqgtr -\frac{\alpha}{g}m + (1-\alpha).$$

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[5] $E^{i} = p^{i}\ (i = N, S)$ is employed to derive these utility functions (20).

[6] This articles uses (2) as $\ln n_{(t)} = \ln n_{(0)} + gt$.

The rate of imitation that equalizes (23) is defined as m_c (referred to as "critical value"). Further, the relation between the welfare of the North and the rate of imitation is revealed in greater detail;

$$
\begin{aligned}
&\left(\frac{m}{g\gamma}\right)^{\alpha} < -\frac{\alpha}{g}m+(1-\alpha) \quad \Leftrightarrow \quad \frac{dU^{N}_{(0)}}{dm}>0 \qquad \text{If} \quad 0<m<m_C \\
(24)\quad &\left(\frac{m}{g\gamma}\right)^{\alpha} = -\frac{\alpha}{g}m+(1-\alpha) \quad \Leftrightarrow \quad \frac{dU^{N}_{(0)}}{dm}=0 \qquad \text{If} \quad m=m_C \\
&\left(\frac{m}{g\gamma}\right)^{\alpha} > -\frac{\alpha}{g}m+(1-\alpha) \quad \Leftrightarrow \quad \frac{dU^{N}_{(0)}}{dm}<0 \qquad \text{If} \quad m_C<m
\end{aligned}
$$

If the IPR regulation is extremely strong at the beginning, which implies that the rate of imitation is close to zero, a relaxation of IPRs increases the rate of imitation and improves the welfare of the North by the effect of the interregional allocation of manufacturing. However, when the rate of imitation attains its critical value, the effect of the interregional allocation of manufacturing should get balanced by the effect of the terms of trade. Further, if the rate of imitation is greater than its critical value, the effect of the terms of trade should exceed the effect of the interregional allocation of manufacturing. These relations between rate of imitation and the welfare of the North are shown in Figure 1.

In order to maximize its welfare through the regulation of IPRs, the Northern government should control the rate of imitation, setting it as equal to its critical value.

<Figure 1>

3 Change in the Rate of Imitation and the Welfare of the South

The substitution of (13) into (21-b) and the differentiation with respect to m results in

$$
(25)\quad \frac{dU^{S}_{(0)}}{dm}=\frac{1}{\rho(\varepsilon-1)}\left[\bar{\zeta}\left(\gamma\cdot\frac{\bar{\zeta}}{1-\bar{\zeta}}\right)^{-\alpha}+\left(1-\bar{\zeta}\right)\right]^{-1}\left[\left\{\left(\gamma\cdot\frac{\bar{\zeta}}{1-\bar{\zeta}}\right)^{-\alpha}-1\right\}-\frac{\alpha}{1-\bar{\zeta}}\left(\gamma\cdot\frac{\bar{\zeta}}{1-\bar{\zeta}}\right)^{-\alpha}\right]\left\{\frac{-g}{(g+m)^2}\right\}.
$$

It is evident that an increase in the rate of imitation always positively affects the welfare of the South, causing the two foregoing effects to contribute to the South's improvement. This relation between the rate of imitation and the welfare of the South is shown in Figure 2.

<Figure 2>

IV Effects on the Welfare of the North and South

In this section, we will investigate the changes in the welfare of the North and South in the case of the expansion of the labor market in the South and in the case of the growth in the rate of innovation in the North.

1 Welfare Effects in the case of the Expansion of the Labor Market in the South

In the beginning, we will analyze how the expansion of the labor market in the South affects the welfare of each country. Using (21-a), (21-b), and (13), we can obtain these results,

$$(26)\qquad \frac{\partial U_{(0)}^{N}}{\partial \gamma}=\frac{1}{\rho(\varepsilon-1)}\left[\bar{\zeta}+(1-\bar{\zeta})\left(\gamma\cdot\frac{\bar{\zeta}}{1-\bar{\zeta}}\right)^{\alpha}\right]^{-1}\left\{\frac{\alpha(1-\bar{\zeta})}{\gamma}\cdot\left(\gamma\frac{\bar{\zeta}}{1-\bar{\zeta}}\right)^{\alpha}\right\}>0 \quad \text{and}$$

$$(27)\qquad \frac{\partial U_{(0)}^{S}}{\partial \gamma}=\frac{1}{\rho(\varepsilon-1)}\left[\bar{\zeta}\cdot\left(\gamma\cdot\frac{\bar{\zeta}}{1-\bar{\zeta}}\right)^{-\alpha}+(1-\bar{\zeta})\right]^{-1}\left\{-\frac{\alpha\bar{\zeta}}{\gamma}\cdot\left(\gamma\frac{\bar{\zeta}}{1-\bar{\zeta}}\right)^{-\alpha}\right\}>0$$

The intuition behind this set of results is easy to explain. The expansion of the labor market in the South increases the quantity of Southern products and decreases their prices. As a result, the welfare of the North is higher and that of South is lower due to the effects of the terms of trade.

Next, we will consider how the expansion of the labor market in the South affects the optimal imitation rate at which the welfare of the North is maximized. (see Figure 3-b). We can calculate this by using (24) appropriately.

$$(28)\qquad \frac{dm_c}{d\gamma}=\frac{mg\left(\dfrac{m}{g\gamma}\right)^{\alpha}}{\gamma\left\{g\left(\dfrac{m}{g\gamma}\right)^{\alpha}+m\right\}}>0$$

We can explain this result as follows. Equation (28) indicates the relation between m_c and γ so that $\partial U_{(0)}^{N}/\partial m=0$ is satisfied. Therefore, in order to satisfy this condition, the two effects, terms of trade and interregional allocation of manufacturing, should be balanced. The expansion of the labor market in the South improves terms of trade in the North, causing an imbalance between the two effects. In order to balance the two effects again, the fraction of unimitated products should decrease due to the fact that the decrease in the fraction of these products deteriorates the terms of trade in the North. Therefore, in order to sustain the maximization of the welfare of the North, the

rate of imitation should be increased.

Therefore, from (26), (22), and (28), the total effect on the welfare of the North can be calculated as follows:

$$(29)\quad \left.\frac{\partial U^{N}_{(0)}}{\partial \gamma}\right|_{m=m_C} = \frac{\partial U^{N}_{(0)}}{\partial \gamma} + \frac{\partial U^{N}_{(0)}}{\partial m_C}\cdot\frac{\partial m_c}{\partial \gamma}$$

$$= \frac{1}{\rho(\varepsilon-1)}\left[\bar{\zeta} + (1-\bar{\zeta})\left(\gamma\cdot\frac{\bar{\zeta}}{1-\bar{\zeta}}\right)^{\alpha}\right]^{-1}\left\{\frac{\alpha(1-\bar{\zeta})}{\gamma}\cdot\left(\gamma\frac{\bar{\zeta}}{1-\bar{\zeta}}\right)^{\alpha}\right\} > 0$$

This result comprises both the direct effect and indirect effect that is caused by the change in the optimal imitation rate. The second term on the right-hand side, that is, the indirect effect, equals zero by the envelope theorem. Thus, we can evaluate the total effects on the welfare of the North only by the direct effect, which can be interpreted as has been indicated.

On the other hand, from (27), (25), and (28), the total effect on the welfare of the South can be calculated as follows:

$$(30)\quad \left.\frac{\partial U^{S}_{(0)}}{\partial \gamma}\right|_{m=m_c} = \frac{\partial U^{S}_{(0)}}{\partial \gamma} + \frac{\partial U^{S}_{(0)}}{\partial m_C}\cdot\frac{\partial m_c}{\partial \gamma} = 0\,.$$

The total effect on the welfare of the South as well as that on the welfare of the North should be discussed by using the direct and indirect effects. This calculation differs from the effect on the welfare of the North in that we use equation (24) without the envelope theorem.

This result can be comprehended as follows. The first term on the right-hand side represents that the welfare of the South is lowered by the effects of the terms of trade. The second term on the right-hand side reveals that the expansion of the labor market in the South increases the rate of imitation at which the welfare of the North can be maximized by the Northern government. Further, it leads to an increase in the welfare of the South by the effects of the terms of trade and of the interregional allocation of manufacturing. By using (24), the negative effect of the first term and the positive effect of the second term are balanced perfectly. Thus, we obtain the following proposition.

As shown in following proposition, these results can be applied to the case of the expansion of the labor market in the North.

Proposition 1

With the expansion of the labor market in the South (North), there is a definite increase (decrease) in the welfare of the North. However, there is no change in the welfare of the South.

2 Welfare Effects in the case of the Growth in the Rate of Innovation

Using (21-a) and (13), we can examine how the growth in the rate of innovation affects the welfare of the North.

$$(31)\quad \frac{\partial U_{(0)}^{N}}{\partial g}=\frac{1}{\rho(\varepsilon-1)}\left[\frac{1}{\rho}+\left\{\bar{\zeta}+(1-\bar{\zeta})\left(\gamma\cdot\frac{\bar{\zeta}}{1-\bar{\zeta}}\right)^{\alpha}\right\}^{-1}\left\{1-\left(\gamma\cdot\frac{\bar{\zeta}}{1-\bar{\zeta}}\right)^{\alpha}\left(1-\frac{\alpha}{\bar{\zeta}}\right)\right\}\left\{\frac{m}{(g+m)^{2}}\right\}\right].$$

In this case, the growth in the rate of innovation has two types of effects on the welfare of the North. As shown in (20-a), one effect is that on the first term of the right-hand side, which is a positive effect. The other effect is that on the second term of the right-hand side, which implies an increase in the fraction of the unimitated products. An increase in the fraction of the unimitated products has a negative effect through the effects of the interregional allocation of manufacturing, whereas it has also a positive effect through the effects of the terms of trade. Since we cannot ascertain the magnitude of these effects, we cannot examine how the growth in the rate of innovation affects the welfare of the North.

By using (21-b) and (13), we can examine how the growth in the rate of innovation affects the welfare of the South.

$$(32)\quad \frac{\partial U_{(0)}^{S}}{\partial g}=\frac{1}{\rho(\varepsilon-1)}\left[\frac{1}{\rho}+\left\{\bar{\zeta}\left(\gamma\cdot\frac{\bar{\zeta}}{1-\bar{\zeta}}\right)^{-\alpha}+(1-\bar{\zeta})\right\}^{-1}\left\{\left[\left(\gamma\cdot\frac{\bar{\zeta}}{1-\bar{\zeta}}\right)^{-\alpha}-1\right]-\frac{\alpha}{1-\bar{\zeta}}\left(\gamma\cdot\frac{\bar{\zeta}}{1-\bar{\zeta}}\right)^{-\alpha}\right\}\left\{\frac{m}{(g+m)^{2}}\right\}\right]$$

Similar to the case of the North, we discuss the welfare of the South with using two types of effects. As is shown in (20-b), the first effect is that on the first term of the right-hand side, which is a positive effect. The second effect is that on the second term of the right-hand side, which implies an increase in the fraction of unimitated products. An increase in the fraction of these products has a negative effect through both the effects of the interregional allocation of manufacturing and those of the terms of trade. Thus, at this stage we cannot examine how the growth in the rate of innovation affects the welfare of the South.

Next, we will consider how the growth in the rate of innovation affects the optimal rate of imitation. We can obtain this by using (24) appropriately,

(33) $$\frac{dm_c}{dg} = \frac{g}{m} > 0 .$$

This result is interpreted as follows. This equation shows the relation between m_c and g so that $\partial U^N_{(0)} / \partial m = 0$ is satisfied. Therefore, in order to satisfy this condition, the fraction of the unimitated products must remain constant in (22). Thus, the rate of imitation that sustains the maximization of the welfare of the North should increase.

Finally, we ascertain how the growth in the rate of innovation affects the welfare in both the countries. We verify this by using (31), (22), and (33):

(34) $$\left.\frac{\partial U^N_{(0)}}{\partial g}\right|_{m=m_c} = \frac{\partial U^N_{(0)}}{\partial g} + \frac{\partial U^N_{(0)}}{\partial m_C} \cdot \frac{\partial m_c}{\partial g}$$

$$= \frac{1}{\rho(\varepsilon - 1)} \left[\frac{1}{\rho} + \left\{ \bar{\zeta} + (1-\bar{\zeta}) \left(\gamma \cdot \frac{\bar{\zeta}}{1-\bar{\zeta}} \right)^{\alpha} \right\}^{-1} \left\{ 1 - \left(\gamma \cdot \frac{\bar{\zeta}}{1-\bar{\zeta}} \right)^{\alpha} \left(1 - \frac{\alpha}{\bar{\zeta}} \right) \right\} \left\{ \frac{m}{(g+m)^2} \right\} \right].$$

This result comprises both the direct and indirect effects caused by the change in the optimal imitation rate. The second term on the right-hand side equals zero by the envelope theorem. Therefore, we can evaluate the total effects only by the direct effect. Thus, we cannot examine how the growth in the rate of innovation affects the welfare of the North.

In contrast, we can examine the total welfare effect of the South by using (32), (25), and (33).

(35) $$\left.\frac{\partial U^S_{(0)}}{\partial g}\right|_{m=m_c} = \frac{\partial U^S_{(0)}}{\partial g} + \frac{\partial U^S_{(0)}}{\partial m_C} \cdot \frac{\partial m_c}{\partial g} = \frac{1}{\rho^2(\varepsilon - 1)} > 0 .$$

The first term on the right-hand side represents the direct effect of the growth in the rate of innovation. However, we cannot examine this as shown in (32). The second term on the right-hand side represents the indirect effect of the growth in the rate of innovation, which has a positive effect on the welfare of the South. Interestingly, the two effects, the terms of trade and the interregional allocation of manufacturing, of the first term on the right-hand side average out with the effects of the second term. Thus, we can ascertain the total welfare effect of the South.

Proposition 2

With the growth in the rate of innovation, there is a definite increase in the welfare of the South.

V Conclusion

From our results, we can make the following conclusions:

(1) With the expansion of the labor market in the South (North), there is a definite increase (decrease) in the welfare of the North. However, there is no change in the welfare of the South.

(2) With the growth in the rate of innovation, there is a definite increase in the welfare of the South.

Interestingly, as the labor market in the South expands, the welfare of its counterpart increases, with its own welfare remaining unchanged. Similarly, the expansion of the labor market in the North does not affect the welfare of the South, but decreases the welfare of the North. The expansion of the labor market in the South increases the welfare of the North because it improves the terms of trade in the North. However, the welfare of the South does not decrease as the relaxation of the rate of imitation by the Northern government positively affects the welfare of the South.

Another interesting point is that with the growth in the rate of innovation in the North, the welfare of the counterpart increases. This is because the direct effect is balanced by the indirect effect.

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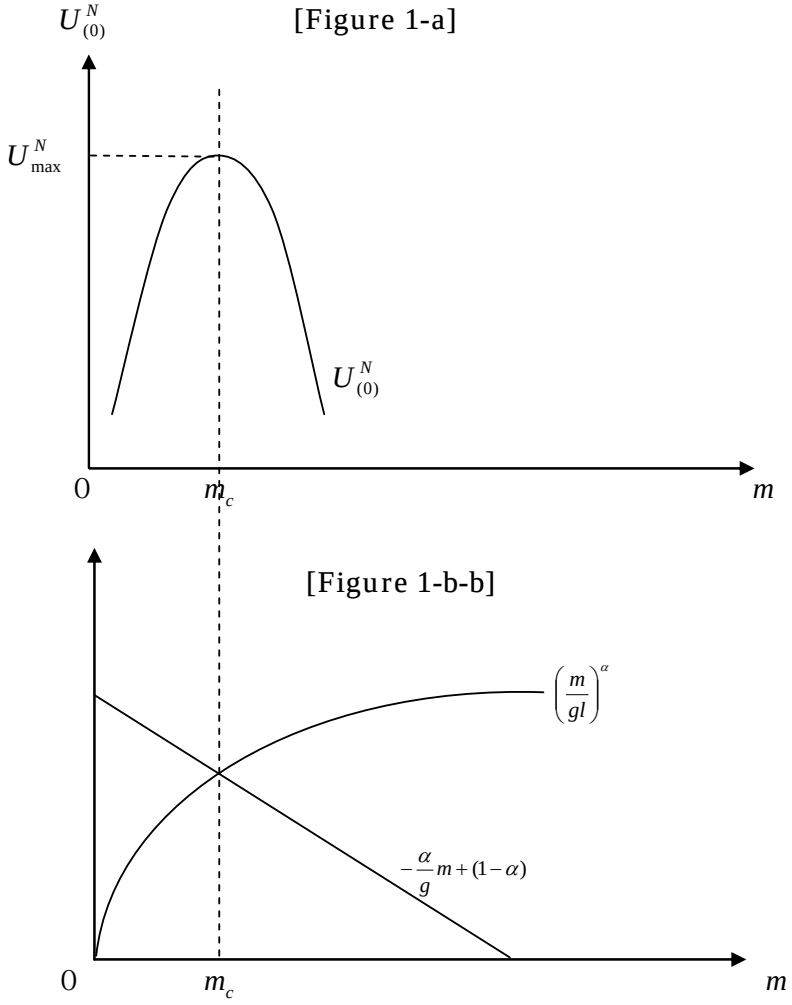
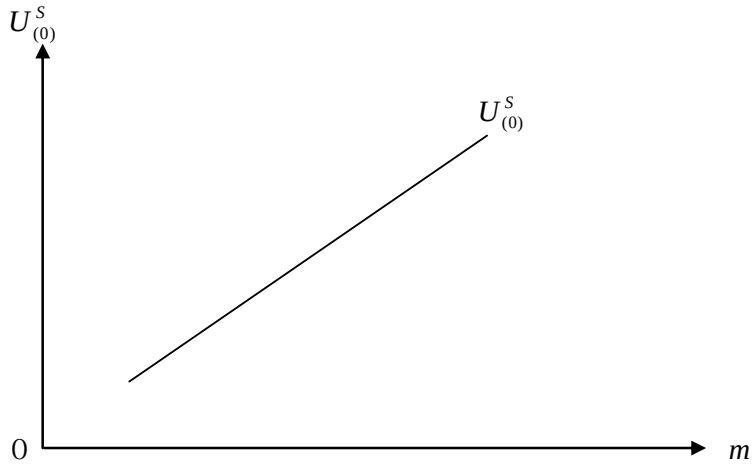
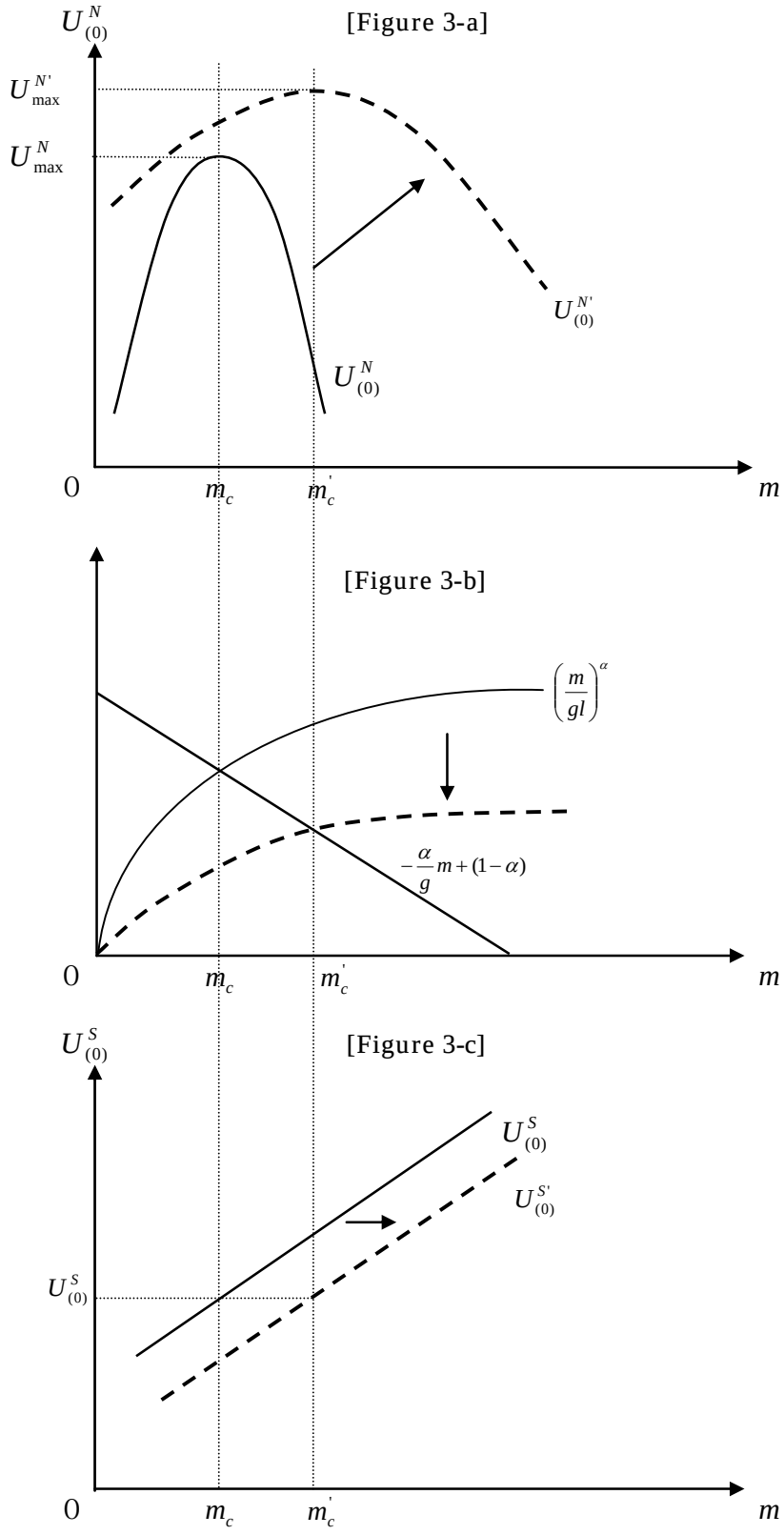
[Figure 1] **The Relation between the Rate of Imitation and Welfare in the North**



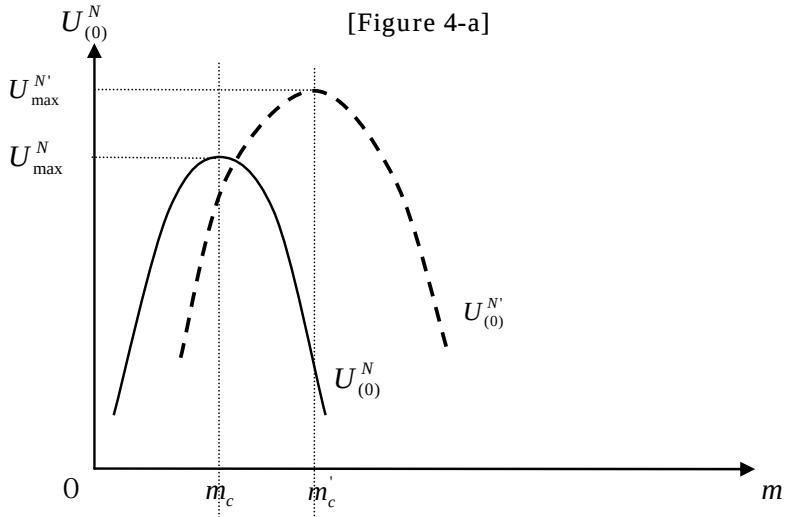
[Figure 2] **The Relation between the Rate of Imitation and Welfare in the South**

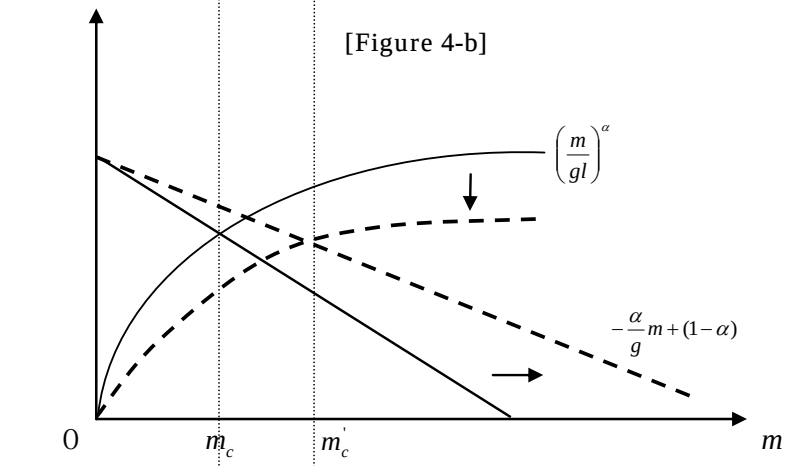


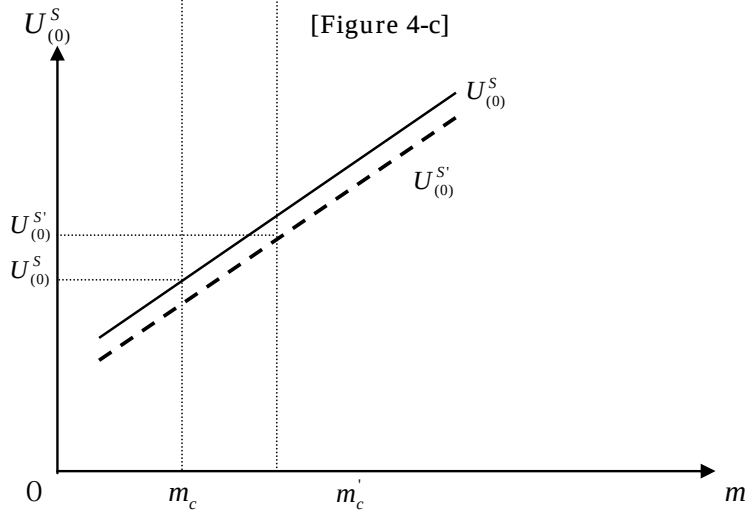
[Figure 3] **In the case of the Expansion of the Labor Market in the South**



[Figure 4][7] **In the case of the Growth in the Rate of Innovation**







[7] In the Figure 4-a and 4-c, it's not clear whether the welfare function of the North and South shifts up or shifts down.