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Licensing, Imitation and Endogenous Growth

Kenichiro Ikeshita*

1 Introduction

The relation between intellectual property rights and economic growth is important issue for endogenous growth theory because to protect innovative idea or methods to produce goods from imitation provides the incentive to innovate new idea and technology. However, if intellectual property rights are too strong, new knowledge and technology may not be able to diverse to the economy. As a result, it is probable that total productivity cannot rise fast and the growth rate is not so large.

When we observe the technology transfer across countries, especially between developed countries and less developed countries, imitation is one of the most important sources of technology transfer. The firms that imitate the technology from developed countries often dominate the market or derives the large share in the production of imitated goods. Foreign direct investment is also important when we consider about technological transfer. It can be regarded as a combination of management resource and labour of host country. Through imitation or foreign direct investment, the location of production can be changed. This hypothesis is called "product-cycle" which is insisted by Vernon(1966).

In recent years, product-cycle is explored in the literatures of endogenous growth theory. Grossman and Helpman (1991a, 1991b) succeeded to integrate growth theory and product cycle. They assume that technology is transferred through imitation by less developed countries. Glass and Saggi(1998) investigates the relation across innovation, foreign direct investment and imitation. They assume in their model, successful imitation reduces technology gap and enables to receive the high quality foreign direct investment. However technological transfer throuth licensing has not been researched enough because introducing licensing contract in the dynamic general equilibrium model may be difficult.

The purpose of this paper is to explore the relationship between innovation and licensing contract with endogenous product-cycle model. We will take imitation by less developed countries into consideration because one of the important factors of licensing is to deter imitation.

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The difficulty of modeling license is to describe the behavior of licensor in developed country and licensee in less developed country. From licensor's point of view, it can earn license fee from the profit of licensed firm and deter imitation by sacrificing a part of its rent, which is given to licensee. On the other hand, from licensee's point of view, it can derive the blueprint of goods that provides profit with no cost once licensing contract is settled. In this paper, we focus on the effect of license fee that deter imitation from less developed country. Then we will assume that technology is transferred in two ways, imitation in less developed country and licensing activity, and that goods produced by the firm in developed country cannot be imitated once the firm in developed country succeeds to make licensing contract.[1)]

The reminder of this paper is organized as follow. In Section 2, we describe the model. In Section 3, we derive the steady state equilibrium. Model is reduced to two relations between rate of innovation and the size of market where firms in developed country produce goods. In Section 4, we explore how the rent share and exogenous imitation affects the rate of innovation and the size of markets. In this paper, higher license rent share increases the rate of innovation and decreases the size of imitated goods markets. This is main conclusion of this paper.

2 The Model

In this section, we set up the model that is considered in this paper. There are two countries called "North" and "South" in this economy. The variables of country i is expressed by superscript i. In each country, there are many consumers and firms. We start up to describe the behavior of consumer.

2.1 The Behavior of Consumer

In this economy, consumers supply their labour and earn wage and receive the interest from their assets. We assume that the population of country i is L^i and one consumer have one unit of labour. They decide the sequence of consumption to maximize their lifetime utility subject to the intertemporal budget constraint. In North and South, consumers have same preference and their lifetime utility is given by

$$U^i=\int_0^\infty e^{-\rho\tau}\log D^i(\tau)d\tau \tag{2.1}$$

where ρ is subjective discount rate. $\log D^i(t)$ is the flow of utility and expressed as

$$\log D^i(t)=\int_0^1\log\left[\sum_m \lambda^m x^i_m(j,t)\right]dj \tag{2.2}$$

1) Precisely, we assume in this paper that licensed technology from developed countries cannot be imitated. On the other hands, firms in less developed countries can imitate foreign goods because international protection of intellectual property rights is not adequate.

j is an index of continuum of products and $j \in [0, 1]$. Consumers choose which line of product to consume. λ is the assessment of quality improvement and m is the number of quality level. Then (λ^m) means the degree of quality m. $x^i_m(j, t)$ is the consumption of quality level m indexed j by the consumer in country i at time t. Because the preference is identical for all consumers and homothetic, the consumer's problem can be aggregated. Let $E^i(t)$ be the total expenditure in country i at time t. The economy-wide intertemporal budget constraint is

$$\int_0^\infty e^{-R^i(t)} E^i(t) dt \leq A^i(0) + \int_0^\infty e^{-R^i(t)} w^i(t) L^i dt. \tag{2.3}$$

$A^i(0)$ is the initial asset held by consumers in country i and $R^i(t)$ is the cumulative interest rate. $w^i(t)$ expresses the wage rate in country i. We can derive the aggregated consumption by maximizing (2.1) and (2.2) subject to (2.3).

First we consider how consumers allocate their income to consumption or saving. The solution of this problem is given by using the Maximum Principle. The first order condition is given by

$$\frac{\dot{E}^i(t)}{E^i(t)} = r^i(t) - \rho \tag{2.4}$$

where $r^i(t)$ denotes the interest rate in country i. The second problem is how consumers allocate their expenditure $E^i(t)$ across product lines. From the characteristics of preference, consumers allocate evenly their expenditure across the product lines. Because the number of products is 1, the expenditure per product is also $E(t)$. The third problem is how consumers allocate the expenditure across the quality levels at each instant for each product. In each product, the quality level that is available for consumers is finite. In each product line, different quality goods are perfect substitutes for consumer. It means that consumers allocate their spending for each product to the quality level with the lowest price that is quality adjusted. Letting $\tilde{m}(j, t)$ be the lowest quality-adjusted price for product j at time t. Then solution of the third problem is given by

$$x^i_m(j, t) = \begin{cases} \dfrac{E^i(t)}{p_{mt}(j)} & (m = \tilde{m}(j, t)) \\ 0 & (\text{otherwise}). \end{cases} \tag{2.5}$$

Now world expenditure is $E^N(t) + E^S(t) = E(t)$ and the world consumption for product indexed j with quality level m is given by $x^N_m(j, t) + x^S_m(j, t) = x_m(j, t)$. The world demand function is

$$x_m(j, t) = \begin{cases} \dfrac{E(t)}{p_{mt}(j)} & (m = \tilde{m}(j, t)) \\ 0 & (\text{otherwise}). \end{cases} \tag{2.6}$$

Finally, we assume that the asset market in this economy is integrated, which means interest rate in North and South is identical,

$$r^N(t)=r^S(t). \tag{2.7}$$

2.2 Firm

The firms that locate in North or South supply the goods to the consumer and earn the profit. The firms in North choose the intensity of R & D to maximize the value of firm. The firm that succeeded to innovate confronts the risk to be imitated by Southern firms. Then firms in the North attempt to make licensing contract with firms in South. Northern firms sacrifice a part of rent and make licensing contracts that give the right to produce a kind of goods. In other words, they deter imitation or reduce the incentive to imitate by providing a part of rent to Southern firm. To introduce this effect of license, we assume that Southern firm cannot imitate licensed goods once licensing contract is made. Moreover, to make licensing contract is costly activity because technology transfer is very different from innovation. A successful technological transfer requires proper design of goods and performance. Then we assume licensing activity like the innovation process. Then whether or not to succeed licensing contract is described as random process and its probability is dependent on the firm's effort. From this background, we set three kinds of market, Northern goods market, licensed goods market and imitated goods market. Now we will focus on the production side on each market.

After succeeding in innovating new technology, successful innovator provides the state-of-the-art to consumer. At the same time, Northern firm faces the risk to be imitated. If imitation happens, Northern firm loses the profit and is driven out of the market. We here assume that the technology that provides no profit can be achieved with no cost. This assumption means that the only state-of-the-art can be produced for each product line. We regard the wage rate in South as numeraire and set the relative wage $w^N(t)/w^S(t)=w(t)$ where $w^N(t)$ is wage rate in North. Moreover we assume that one unit of labour is necessary to produce one unit of good in both country. Finally we assume also $w(t)>1$, which compensates that equilibrium spending is nonnegative.

Here we consider the firms in Northern goods market. The nearest competitors for them are Southern firms that have the production technology that is one quality below the highest quality. Then Northern firm charge the price as

$$p^N(t)=\lambda \tag{2.8}$$

and the quantity of produced is given as $E(t)/\lambda$. Profit earned by Northern firm is

$$\pi^N(t)=E(t)\left(1-\frac{w(t)}{\lambda}\right). \tag{2.9}$$

Next we explore the behavior of licensed Southern firm. Here we formulate the licensing contract as the rent share s, which is the fraction of profit paid to the Northern licensor. Then licensed Southern firm earns $(1-s)$ of the profit. Southern licensee sets the price against other

Southern firms that are able to second level products. The marginal cost that they confront is 1 and they charge the price as

$$p^L(t)=\lambda. \tag{2.10}$$

Then the quantity produced by licensed firm is equivalent to that by Northern firm and their profits is

$$\pi^L(t)=E(t)\left(1-\frac{1}{\lambda}\right). \tag{2.11}$$

Comparing (2.9) and (2.11), it is clear that licensed firms earn more profits than Northern firms.

Next we will describe the firm that imitates the state-of-the-arts. For simplicity, we assume that Northern firm that has the technology to produce the highest quality vanishes if Southern firm imitates that technology. This assumption is not satisfactory because the strategic behavior of firm is ignored. But this assumption makes us to reduce our model more easily and affects the labour constraint only. If this assumption is satisfied, Southern firm can set the monopoly price $p^S(t)=\lambda$ and the quantity produced by Southern firm is same as that of Northern firm. Then in all market, the quantity of goods produced by firm is $E(t)/\lambda$.[2)]

For Northern firm to produce a quality level of product, it must innovate and improve the quality of the product. If it succeeds to innovate, it can receive the profit in the markets. But it faces the risk to be driven out of the market because next innovator is engaged in R & D activity or imitation is occur at exogenous rate m. There is no limit to improve the quality of product, however innovation and imitation proceed one quality. Innovation is occurred in all markets using Northern labour. Similar to Grossman and Helpman(1991), innovation activity is costly and formulated as a random process. The probability to succeed to innovate depends on the R & D effort. Licensing is also costly activity, however it is easier than innovation process. Imitation is exogenous and shows the strength of intellectual property rights. u_I denote the time when Northern firm succeed to innovate and u_L denote the time when Northern firm makes a licensing contract with Southern firm. The probability that $u_I<\tau$ is expressed as

$$\mathrm{Prob}(u_I<\tau)=1-e^{-\int_t^\tau \iota(s)ds}. \tag{2.12}$$

This means the conditional probability that innovation has not been occurred in North until time t. $\iota(t)$ is an intensity of innovation. It can be regarded as a flow of probability that innovation occurs. This intensity depends on an effort by Northern innovator. The probability that $u_L<\tau$ is similarly given by

$$\mathrm{Prob}(u_L<\tau)=1-e^{-\int_t^\tau \phi(s)ds} \tag{2.13}$$

where $\phi(t)$ is an intensity of licensing activity and regarded as a flow of probability that Northern

2) If imitated goods market is perfect competitive, Southern firm sets its price $p^S(t)$ to marginal cost in South, then $p^S(t)=1$ because Southern wage is numeraire in this model.

firm make licensing contract successfully.

Here, we assume that one unit of intensity to innovate needs a units of labour. In other words, a expresses the cost of innovation activity. Similarly, one unit of licensing intensity needs a^L units of labor. In generally, technological transfer is costly but easier than that of innovation. Then we assume that $a > a^L$.

Next we consider the Northern firm's efforts to innovation. We assume that $v^N(t)$ is the market value of Northern firm at time t. When Northern innovator generates innovation intensity $\iota(t)$, the wage paid to Northern labour is $w(t)a\iota(t)$. On the other hand, expected return is $\iota(t)v^N(t)$. Then the net expected profit is given by $\iota(t)v^N(t) - w(t)a\iota(t)$. If $v^N(t) > w(t)a$, the quantity of labour employed in innovation activity is not determined as finite value. Conversely, if $v^N(t) < w(t)a$, labour is not used in innovation sector. Then as the condition that finite quantity of labour is employed, we derive

$$v^N(t) = w(t)a. \qquad (2.14)$$

Next we consider the licensing activity. In our model, license contract is expressed as the Northern firm's share of profit. Rent sharing is often observed in licensing contracts. Generally licensor receives 40% of profit as license fee. Determination of rent share is an interesting problem. However, in order to determine the rent share, we formulate the behavior of Southern firm more precisely. Maybe, we will have to consider the problem which imitation or making licensing contract Southern firm chooses. However, to introduce this problem into product-cycle model is too complicated. Then we set rent share exogenously in this model. Here let s be the licensor's rent share. We assume that s is exogenous and constant over time. When $v^L(t)$ denotes the market value of licensed Southern firm, we can derive a relation between licensing effort and the market values of firms.

From the constancy of s, successful licensor attains a market value of $sv^L(t)$. When licensing intensity is $\phi(t)$, the expected return is $\phi(t)[sv^L(t) - v^N(t)]$. Here we assume that $sv^L(t) - v^N(t) > 0$, which is always satisfied in this model. On the other hand, the wage paid to labour is expressed as $w(t)\phi(t)a^L$. Then if $sv^L(t) - v^N(t) > w(t)\phi(t)a^L$, licensing intensity is not determined as finite value. On the other hand, $sv^L(t) - v^N(t) < w(t)\phi(t)a^L$, licensing cannot happen. The condition for Northern firm choose a positive and finite value of licensing intensity is given as

$$sv^L(t) - v^N(t) = w(t)a^L. \qquad (2.15)$$

The firm in the Northern goods markets invests in licensing activity by using a part of its profits. Moreover, firms in North confront the risk that they lose their rent by exogenous imitation and new innovation. No-arbitrage condition is derived as follow.[3]

3) A dot on variable represents derivative for time. Then $\dot{v}^N = \frac{dv^N}{dt}$.

$$r^N(t)v^N(t)=[\pi^N(t)-\phi(t)w(t)a^L]+\phi(t)(sv^L(t)-v^N(t))-(\iota(t)+m(t))v^N(t)+\dot{v}^N(t) \tag{2.16}$$

where m is exogenous imitation rate. Once license is successful, licensed goods cannot be imitated. However licensed firm also faces the risk of new innovation. Then no-arbitrage condition of Southern licensed firm is given by

$$r^N(t)v^L(t)=\pi^L(t)-\iota(t)v^L(t)+\dot{v}^L(t). \tag{2.17}$$

From (2.15), (2.16) is rewritten as

$$r^N(t)v^N(t)=\pi^N(t)-(\iota(t)+m(t))v^N(t)+\dot{v}^N(t). \tag{2.18}$$

This equation expresses the no-arbitrage condition including licensing activity. Moreover, from (2.14) and (2.15), we can derive $v^L(t)$ as follow.

$$sv^L(t)=w(t)(a+a^L), \tag{2.19}$$

which means $v^L(t)$ is larger than $v^N(t)$.

Next we will mention the measure of the markets. In our model there are three markets, Northern goods market, licensed goods markets and imitated goods markets. Let $\eta_1(t)$, $\eta_2(t)$ and $\eta_3(t)$ be the extent of the markets of Northern goods markets, licensed goods markets and imitated goods markets. Then $\Sigma_i\eta_i(t)=1$.

Finally we consider about resource constraint of North and South. In the labour market in North, the labour demand for innovation is $a\iota(t)$ because innovation activity targets all of the market. Licensing activity is occurred in Northern goods markets. Then $\eta_1(t)a^L\ \phi(t)$ units of labour is employed for licensing activity. Goods are produced in only Northern goods market. Then the labour demand for production is $\eta_1(t)[E(t)/\lambda]$. The condition that demand for labour equals to the total supply of labour is

$$a\iota+\eta_1(t)a^L\phi(t)+\eta_1(t)\frac{E(t)}{\lambda}=L^N. \tag{2.20}$$

Southern labour is used for production only. In licensed goods market, licensed Southern firm is engaged in production and demand for production in the licensed goods markets is $[E(t)/\lambda]$. firms in imitated goods markets also produce goods and the labour demand for imitated goods market is also $[E(t)/\lambda]$. Then the labour market condition in South is given by

$$\eta_2(t)\frac{E(t)}{\lambda}+\eta_3(t)\frac{E(t)}{\lambda}=L^S. \tag{2.21}$$

3 Steady State Analysis

From this section, we will explore the model that is specified above. First, we define the steady state as the state in which all growth rates of variables are constant. However, this does not mean the growth rates of all variables are identical.

3.1 Constant Measure

In this section, we consider about the extent of each market in the steady state. Our interest is the relation between licensing and imitation. we consider the steady state that three markets can exist. In such a steady state, the market measure η_i is constant over time. Then, by focusing on changes of the extents of markets, we can derive new relation across the extents of the markets and intensities. In figure 1, change of the market is illustrated as flow chart.

First, we consider the change of the extent of licensed market η_2. The increase of η_2 is the measure of products that Northern firm succeed to licensing, that is $\eta_1\phi(t)$. The decrease of η_2 is the measure of products that new innovation occurs in the licensed goods market, $\iota(t)\eta_2$. Because η_2 is constant in the steady state,

$$\iota(t)\eta_2=\phi(t)\eta_1, \tag{3.1}$$

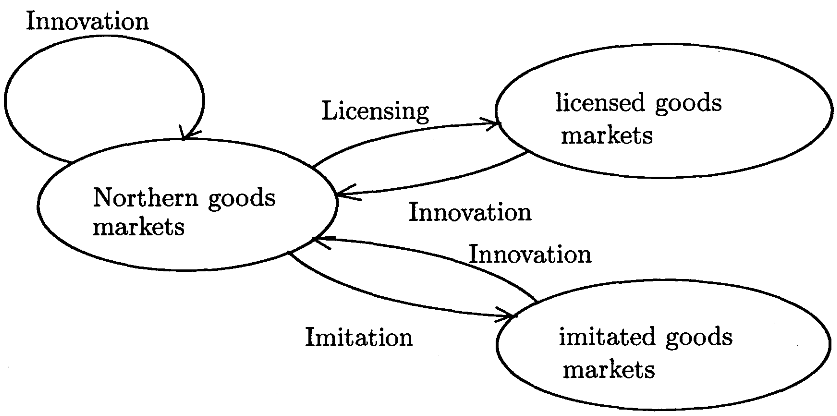
which means that $\phi(t)=\frac{\iota(t)}{\eta_1}\eta_2$. Similarly we can consider the change of the extent of imitated goods market η_3. The increase of η_3 is the measure of products of imitated Northen firm, that is $m\eta_1(t)$. The decrease of η_3 is the measure of products that new innovation occurs in the imitated goods market, that is $\iota(t)\eta_3(t)$. Because η_3 is also constant in the steady state,

$$\iota(t)\eta_3=m\eta_1. \tag{3.2}$$

By using $\eta_2=1-\eta_1-\eta_3$, then we can derive η_2 as a function of $\iota(t)$ and η_1:

$$\eta_2=1-\eta_1-\frac{m}{\iota(t)}\eta_1. \tag{3.3}$$

From (2.21) and the fact that η_i is constant, It is obvious that $E(t)$ is some constant value E, which implies that $r^i(t)=\rho$ in the steady state. Moreover (3.3) shows that ι becomes constant ι in the steady state.



Fugure 1 flow chart
The change of products across three markets

3.2 Determination of Steady State Equilibrium

Here we will reduce the model to the system of ι and η_1. Then we redefine $\eta_1=\eta$. From (2.14) and (2.19), v^N and $v^L(t)$ is expressed as

$$v^N(t)=\frac{E\left(1-\frac{w}{\lambda}\right)}{\rho+\iota+m}=wa. \tag{3.4}$$

$$v^L(t)=\frac{E\left(1-\frac{1}{\lambda}\right)}{\rho+\iota}=\frac{1}{s}w(a+a^L). \tag{3.5}$$

From (3.5), relative wage $w(t)$ is constant. Moreover, by using (3.4) and (3.5), We can confirm Northern wage w is a function of ι only and expressed by

$$w=\frac{\lambda(a+a^L)(\rho+\iota)-(\lambda-1)sa(\rho+\iota+\mathrm{m})}{(a+a^L)(\rho+\iota)}. \tag{3.6}$$

This equation means that w is larger than 1 if there is no imitation. But if the rate of imitation is too large, Northern wage is lower than that of South and Southern licensed firm earns smaller flow of profit. Moreover comparing (3.4) and (3.5), if Northern wage is lower than that of South, there is a possibility to v^L is smaller than v^N. Here we assume that $w>1$ for any value of ι. For this assumption to be satisfied, m must satisfy the following condition[4)]

$$(a+a^L)\rho>sa(\rho+m). \tag{3.7}$$

By substituting (3.6) into (3.5), E is a function of ι only. E is expressed as

$$E=\frac{\frac{1}{s}\Omega(\iota)}{1-\frac{1}{\lambda}}, \tag{3.8}$$

where $\Omega(\iota)$ is a linear function of ι and derived as

$$\Omega(\iota)=\lambda(a+a^L)(\rho+\iota)-(\lambda-1)sa(\rho+\iota+m). \tag{3.9}$$

If (3.6) is satisfied, $\Omega(\iota)$ is positive for any value of ι. η_2, η_3 and ϕ are rewritten by using η and ι. Then labour constraint in North is reduced to the relation of η and ι.

$$a\iota+a^L(\iota-\iota\eta-\eta m)+\frac{\eta}{\lambda}\frac{\frac{1}{s}\Omega(\iota)}{\left(1-\frac{1}{\lambda}\right)}=L^N. \tag{3.10}$$

In figure 2, This relationship of η and ι is depicted as downward-sloping curve. Because this curve shows the labour constraint of north, we call this curve LN-curve. The shape of this equation is important for the below analysis. After some calculation, we can derive the condition that LN-curve has negative slope. This condition is given by

4) $w>1$ implies that $\lambda(a+a^L)(\rho+\iota)-(\lambda-1)sa(\rho+\iota+m)-(a+a^L)(\rho+\iota)>0$. The LHS of this inequation is linear function of ι with positive slope. If the LHS has positive value when $\iota=0$, the LHS is positive for all ι and $w>1$, which corresponds with (3.7).

$$\frac{L^N}{a+a^L} > \frac{m+\dfrac{a}{a+a^L}\rho-\dfrac{1}{s}\dfrac{\lambda}{\lambda-1}\rho}{\dfrac{1}{s}\dfrac{\lambda}{\lambda-1}-1}. \tag{3.11}$$

(3.11) is a little complicated. But we can immediately confirm this condition is satisfied when the scale of economy L^N is enough large and the rate of imitation m is sufficiently small. We here assume (3.11) is satisfied. Similarly we can rewrite the south labour constraint to the relation of η and ι. We can easily derive

$$\frac{1}{\lambda}(1-\eta)\frac{\dfrac{1}{s}\Omega(\iota)}{\left(1-\dfrac{1}{\lambda}\right)}=L^S. \tag{3.12}$$

Similarly this relationship of ι and η is illustrated in figure 2. We call this curve LS-curve. We can easily confirm that this equation shows upward-sloping curve. The intersection of LN-curve and LS-curve indicates the steady state equilibrium of η and ι.

4 Comparative statics

In this section, we explore how the licensing rent share and imitation rate affect to the innovation and the measure of goods markets. Does large licensing share shrink the size of imitated goods markets ? Can small rate of imitation decrease the risk to imitate and promote innovation ?

First we consider the case in which rent share s increase. In this case, we can easily shows

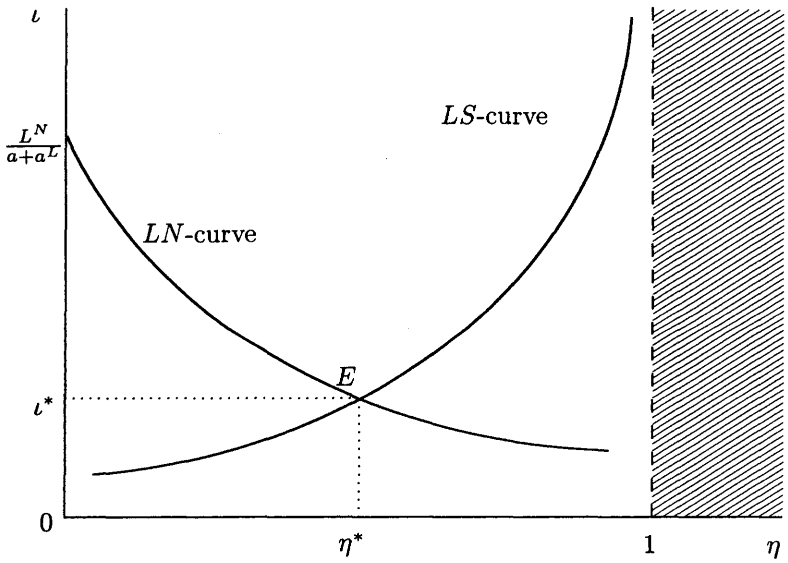


Figure 2 The determination of ι and η in the steady state

that LN-curve shifts upward. High license rent promotes the licensing and labor is released from the production of goods. Moreover this change raises the value of licensed firm. This effect increases the world expenditure. The increase of rent share also shifts the LS-curve upward. Now it is obvious to increase ι. Moreover we can show that η decreases in this case from the comparative statics. Here we remember that η_3 is expressed as $\eta_3=\frac{m\eta}{\iota}$. Then the measure of the imitated market becomes small and that of licensed goods market increases. Higher licensing rent share promotes the licensing activity and the innovation activity. The increase of innovation means that the Southern firms are immediately driven out of the market.

proposition 1 *The extent of Northern goods market decreases, the extent of the imitated goods market decreases and the rate of innovation increases with a larger licensing rent share.*

Figure 3 shows the shifts of LN-curve and LS-curve when rent share s increases.

Next we consider how the change of imitation rate affects the steady state equilibrium. Similar to the increase of rent share, both LN-curve and LS-curve shifts upward when m increases. Then rate of innovation increases, however, different to the case in which rent share increases, the change of η is ambiguous. When the rate of imitation increases, labour in North is released from the production activity and more resources are used for R & D activity. But whether or not increased innovation promote licensing activity depends on the parameters. If increased innovation can promote licensing, the extent of Northern goods market becomes small and that of imitated goods market also becomes small.

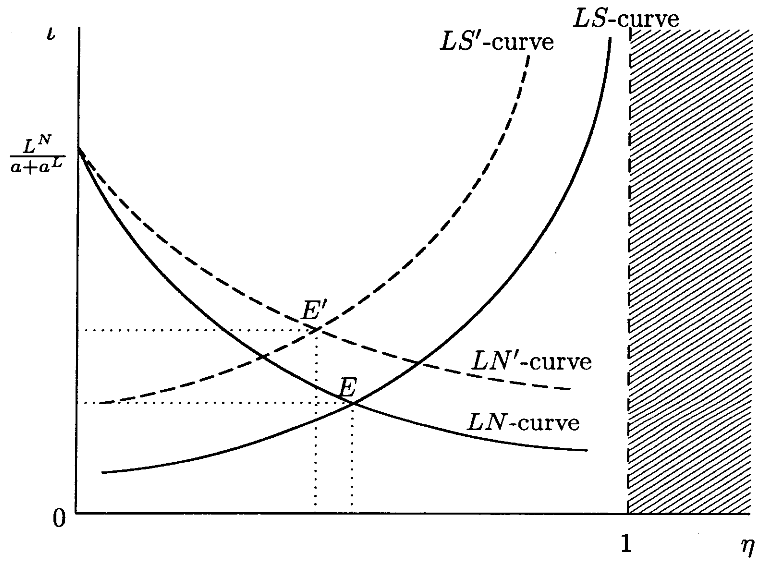


Figure 3 The increase of rent share s ι increases and η decreases

proposition 2 *The rate of innovation increases with a larger rate of imitation.*
Figure 4 shows that the shifts of LN-curve and LS-curve when rate of imitation m increases.

Above two conclusions give us an important question. We remember that one of the important property of licensing contract is to deter imitation. We can easily imagine that the rate of imitation have negative relationship with rent share because higher rent share decrease the incentive to imitate Northern goods. Because we do not formulate the incentive to imitate goods, introducing negative relation between rent share and rate of imitation may become an interesting extension of our model.

5 Conclusion

In this paper we constructed quality-ladder product cycle model that technology is transferred through licensing contract and imitation. One of the important property of licensing is to deter imitation. Then we assumed that Southern firm cannot imitate goods after licensing contract is made. In other words, licensing is effective method to protect Northern intellectual property rights. In the situation where licensing and imitation are competitive as source of technological transfer, we explored how the licensing contract or imitation can affect the innovation.

Model is reduced to the two curves of rate of innovation ι and the extent of the Northern goods market η. We derived LN-curve as downsloping curve and LS-curve as upsloping curve and steady state values of ι and η uniquely exists. These conclusion is not so different from earlier

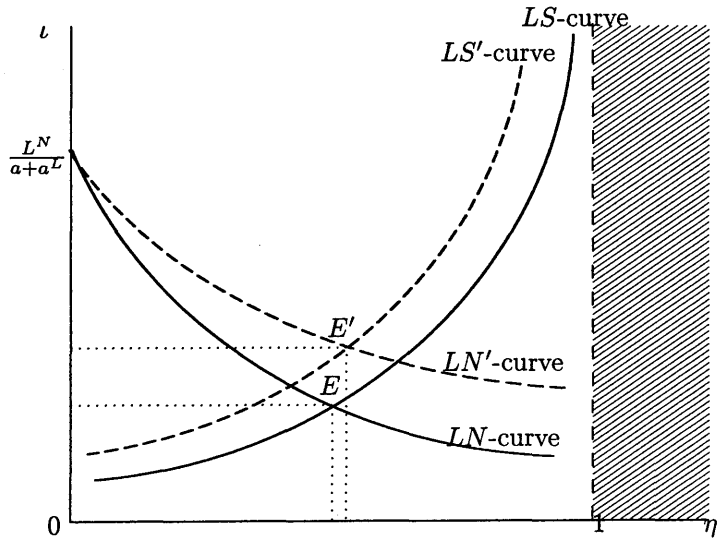


Figure 4 The increase of imitation rate m
ι increases but the change of η is ambiguous
(In this fugure, two curves are depicted as η increases)

study about innovation and technological transfer.

On the other hand, the conclusion of comparative statics is interesting. Higher licensing rent share increases the rate of innovation and shrinks the extent of Northern goods markets, which means higher rent share in licensing contract have an effect to decrease the size of imitated goods market. Even in the case where rate of imitation increase, we can derive the conclusion that the rate of innovation increases.

In this paper, there remain some problems that must be considered more deeply. First, market structure of imitated goods market is ad hoc, that is, strategic behavior of firm is completely omitted. One of the solution of this problem is to assume that imitated market is perfectly competitive. Because we did not considered about the incentive to imitate, this may be plausible assumption. However, we treat three kinds of market in this model. Then, the conclusion may become more complicated.

Second, we mentioned above, Introducing an effect that high rent share decreases the rate of imitation may be an interesting extension of our model. From the analysis of section 4, both rent share and the rate of imitation commonly have the positive correlation with the rate of innovation. Moreover endogenizing licensing rent share is an interesting problem.

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