Title	Dynamic Analysis of International Trade, Economic Growth and Development
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Citation	大阪大学, 1999, 博士論文
Version Type	VoR
URL	https://doi.org/10.11501/3155534
rights	
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Dynamic Analysis of International Trade, Economic Growth and Development

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June 1999

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Acknowledgements

1 Introduction

1.1 Introduction

The latter half of the twentieth century saw the remarkable growth performance of the East Asian economies. In Fig. 1.1, the average annual growth rates of the real per-capita GDP of 131 economies between 1960 and 1990 are plotted against those of the real per-capita trade volume.[1] This figure tells us two points. First, the world economy was getting more and more open over the years. The slope of the regression line in Fig. 1.1 is flatter than that of the 45-degree line, implying that trade expanded at a higher rate than income. Second, the fastest-growing East Asian economies experienced the fastest growth of trade. All of the eight HPAEs (High-Performing Asian Economies: Hong Kong, Indonesia, Japan, Korea Republic, Malaysia, Singapore, Taiwan, and Thailand)[2] are located in the far northeastern side of the whole data in Fig. 1.1. Facing these facts, we conjecture that examining the links between trade and growth is important in understanding the secret of the East Asian miracle. The purpose of this dissertation is to give some theoretical frameworks for analyses of the relationships between international trade, economic growth and development.[3]

Economists have used two criteria of economic growth in developing economies. The first is an absolute one: how fast does a developing economy grow no matter how fast the other economies grow? According to this view, only resource allocation in the developing economy matters. The second is a relative one: how fast does a developing economy grow compared with the other economies? This view brings up not only resource allocation in the developing economy but also income distribution in the world. In the context of trade and growth, the economists have asked two questions each of which corresponds to each criterion.

First, how does trade policy affect growth and welfare? In practice, most governments in the world are imposing a variety of trade barriers for several reasons:

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[1] Source: Summers and Heston (1994). Economies with at least 20 years of observation are chosen as the sample.

[2] The World Bank (1993) has begun to use this grouping.

[3] We define economic growth as a rise in the real national income, and economic development as an overall rise in the real income of every class. Then logically economic growth is the necessary condition for economic development. From now on, we do not distinguish between these terms and mainly use "economic growth" in order to begin with macroeconomic rather than microeconomic analysis.

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they protect declining industries under pressure from strong interest groups; they find collecting revenues at customs easier than from domestic households and firms given their tax structure; they seek to bring up infant industries which are "promised" to lead the economies in the future. Can these trade barriers be justified in the light of growth and welfare? Or is free trade the best?

Second, can developing Southern economies catch up with developed Northern economies? The data gives an ambiguous answer. Fig. 1.2 plots the average annual growth rates of the real per-capita GDP of 103 economies between 1960 and 1990 against the logarithmic values of the real per-capita GDP in 1960.[4] It shows that most of the HPAEs grew faster than the developed OECD (Organization for Economic Co-operation and Development) economies and were catching up, while most of the other developing economies grew slower than the developed economies and were not catching up. Does the income of South really converge to that of North? If so, in what case?

The purpose of this chapter is to find a clue for solving these questions. Section 1.2 argues that the open endogenous growth theory is the appropriate analytical tool. Next, we make a survey on the open endogenous growth theory.[5] Section 1.3 examines the effect of trade policy on growth and welfare. Section 1.4 deals with convergence controversy. Section 1.5 focuses on technology transfer, a topic derived from section 1.4. Finally, section 1.6 gives an introduction to the following chapters.

1.2   Why endogenous growth?

To consider the questions raised in section 1.1, we apply the endogenous growth theory to open economies. In the endogenous growth models, the growth rate[6] is endogenously determined by policy as well as technology, endowment, and preference. Neither the traditional trade theory nor the neoclassical growth theory is helpful to examine the relationships between trade and growth.

The traditional trade theory is not good at analyzing dynamic problems, since the theory is essentially static. There are two topics which relates growth to trade. First, the immizerizing growth argument says that an open economy might be hurt by growth

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[4] Source: Summers and Heston (1994).

[5] For the other surveys on the open endogenous growth theory, see Aghion and Howitt (1998, Chap. 11) and Long and Wong (1997).

[6] Without comment, the term "the growth rate" usually means the growth rate of the real per-capita national income.

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either when growth is biased toward an export good so that the terms of trade worsen sufficiently, (Bhagwati 1958) or when growth is biased toward a tariff-ridden import good so that the tariff revenue shrink sufficiently. (Johnson 1967) Second, the infant industry argument states that it might be good to protect the infant industry, in which firms can not operate in free trade, but will be able to do after having sufficient amount of production experience.[7] By protecting the infant industry, the economy will produce or even export the good which would be imported in free trade. Although these arguments explain the causality from growth to trade, they do not explicitly formulate the mechanics of growth.

Nor is the neoclassical growth theory satisfactory, since it has no route by which trade affects the growth rate in the steady state, the state in which all variables grow at constant rates. The neoclassical growth theory since Solow (1956) is characterized by the neoclassical constant-returns-to-scale production functions and diminishing returns to reproducible factors such as capital.[8] Since Oniki and Uzawa (1965) developed a two-sector, two-factor, two-economy model, many papers on the open neoclassical growth theory had been written until 1970s.[9] It is true that the open neoclassical growth models analyze the interactions between trade and growth: capital accumulation affects the production possibility and then the volume of trade, while trade affects the volume of investment good available for use and then capital accumulation. However, as long as the neoclassical properties are preserved, the steady-state growth rate is entirely determined by the rate of exogenous technological progress.

Since the mid-1980s, the endogenous growth theory has been developed in order to explain the determinants of growth by logical reasoning within the models. We need the endogenous growth models in order to discuss how various trading environments affect growth and welfare of developing economies.

1.3   Trade policy, growth and welfare

How does trade policy affect growth and welfare? It seems at first glance that an economy achieves higher growth rate and welfare, the more open trade policy the government takes. Dollar (1992), Edwards (1992), and Sachs and Warner (1995),

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[7] For surveys on the infant industry argument, see Corden (1974, Chap. 9) and Itoh et al. (1991, Chap. 4).

[8] The neoclassical properties in production technology are stated in Barro and Sala-i-Martin (1995, pp. 16).

[9] For a survey on the neoclassical growth theory in open economies, see Findlay (1984, Sec. 2.3).

among others, empirically support this view. However, in a recent paper, Rodriguez and Rodrik (1999) point out methodological flaws in these early papers and rerun some revised regressions to find little evidence that the open trade policy is significantly associated with growth. Facing this ambiguous fact, the theory has to explain in what case openness is good for growth and in what case it is bad.

In this section, we concentrate on the small-open endogenous growth models. This is largely because the knowledge obtained in the small-open models is indispensable to consider the same things in the multi-economy models. Moreover, the multi-economy models are too complex to analyze the whole effect of a policy change: the time path of terms of trade changes; the vector of state variables shows transitional dynamics until the system reaches the new steady state. As the readers who are familiar with public economics know, the effect of trade policy depends on whether the economy is inherited with some kinds of market failure such as externalities, imperfect competition, and so on.

Models without market failure

Let us first grasp the basic structure of the endogenous growth models in competitive settings. Suppose that good Y is produced under the following production function:

$$Y = F(K,Z),$$

where K and Z denote representative reproducible factor (e.g., capital) and other input, respectively. It is assumed that $F(\cdot)$ has positive and diminishing marginal products and exhibits constant returns to scale. A factor is said to be *reproducible* when their supply is not constrained by exogenous elements. The per-capita output continues to grow if the value of marginal product of K (VMP_K) has a sufficiently high asymptotic lower bound as K becomes large. There are two distinct conditions which give rise to the boundedness of VMP_K:

- Z is also reproducible. (Romer 1986, Lucas 1988, Barro 1990, among others[10])

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[10] In Romer (1986), K enters in Z as the Marshallian external economies. In Lucas (1988), Z is reproducible human capital. In Barro (1990), publicly provided production services appear in Z. They retain the perfect-competition paradigm, although Romer (1986) and Barro (1990) assume market failure.

$\cdot$ Z is not essential for production. (Solow 1956, Sec. 4)

In either of these cases, the market mechanism endogenously determines the growth rate of the per-capita national income in the steady state.[11]

Lee (1993, Sec. 3) provides a simple model to show that free trade is growth-maximizing. He assumes that final good Y is produced from capital K and foreign intermediate good M under the neoclassical production function. We normalize the world price of M to unity, since its value has no qualitative importance. The first-order conditions of profit maximization are given by

$$r = F_K(K,M) = F_K(K/M,1),$$

$$1+\tau = F_M(K,M) = F_M(K/M,1),$$

where r and τ denote interest rate and ad-valorem tariff rate, respectively, and a subscript represents differentiation with respect to the argument.[12] The second equality in each condition follows since the first partial derivative of the homogeneous-of-degree-one function $F(\cdot)$ is homogeneous of degree zero. Given τ, K/M is determined from the second condition, and then r is determined from the first condition. In this model, the VMP_K does not decline with capital accumulation over time, because M is also reproducible: firms can buy as much amount of M as they want at the given domestic price. Thus, endogenous growth occurs in the steady state.[13] Noting that the supply of K is fixed at each point in time, raising τ decreases the demand for M, which in turn pulls down the VMP_K.[14] Consequently, the steady-state growth rate is decreasing in the tariff rate.

Osang and Pereira (1996) present a model with physical and human capital, and numerically examine the effects of imposing several tariffs on the growth rate. In their model, final good is produced from physical and human capital under the neoclassical technology, so that the growth rate mainly depends on how the two types of capital are accumulated. Firms accumulate physical capital using domestic final good and foreign investment good, while accumulate human capital using a fraction of human capital and

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[11] For a review of several prototype endogenous growth models, see Barro and Sala-i-Martin (1995).

[12] The VMP_K is equal to rental, which in turn is equal to the interest plus depreciation rate because of the no-arbitrage condition. We neglect capital depreciation only for simplicity.

[13] Furthermore, the economy is always in the steady state, because there is only one state variable that evolves over time and can not be chosen perfectly freely in each period.

foreign technology good. Households consume domestic final good and foreign consumption good. Let us concentrate on the effect of a consumption tariff on the steady-state growth rate.[15] If the tariff revenue is transferred to the households in a lump-sum manner, raising the tariff rate has no growth effect, since the tariff does not affect the incentive of accumulating physical and human capital. If the tariff revenue is used for subsidizing investment in physical capital, however, the growth rate rises with the tariff rate. Note that the growth rate is independent from the pure effect of the tariff in any case.

The welfare effect of any kind of tariff is necessarily negative in these models. This is because they assume no market failure. In the absence of market failure, the competitive equilibrium allocation is Pareto optimal. Then any form of government intervention, including tariffs, results in an allocation which is inferior to the competitive equilibrium one. Therefore, free trade is optimal in these models.

Models with market failure

Romer (1990) and Grossman and Helpman (1991a) have made an innovation in the field of growth theory by means of their models with endogenous technological change. In their R&D models with expanding product variety, the central feature is that technology exhibits increasing returns due to specialization, which is named by Romer (1987). Let us assume the following production function:

$$X = G(\{x(j)\}_{i=0}^{n}) = (\int_{0}^{n} x(j)^{\alpha} dj)^{1/\alpha}; \alpha \in (0,1),$$

where X, $x(j)$, and n denote index of differentiated goods, variety $j \in [0,n]$ of differentiated good, and continuous measure of the number of varieties of differentiated goods, respectively. When the varieties of differentiated goods are regarded as intermediate (or consumption) goods, X represents the output of final good or the composite of intermediate goods (or utility). Given n, $G(\cdot)$ is constant returns to scale in all varieties. However, noting that $x(j) = x \forall j$, we have

$$X = n^{1/\alpha} x = n^{(1-\alpha)/\alpha} (nx).$$

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[14] We use $F_{MM} < 0$, $F_{KK} < 0$, and $F_{KK}K + F_{KM}M = 0$ (Euler's formula) to get this outcome.

[15] If the ratio of physical to human capital in the initial period is different from that in the steady state, the economy exhibits transitional dynamics before reaching the steady state.

Given the total quantity of differentiated goods nx, X is larger, the larger n is. That is, increasing division of labor among different varieties is good for productivity. In this type of models, endogenous growth is driven by profit-maximizing R&D firms which successively create new varieties. The major market failure lies in the differentiated good sector: each firm producing variety j, believing that its decision does not affect the entire sector, takes monopoly pricing.

Grossman and Helpman (1991b) apply the structure of the R&D models to a small open economy, and investigate the possibility of growth- and welfare-enhancing trade policy. In their model, there are two perfectly competitive final good sectors, one monopolistically competitive intermediate good sector, one perfectly competitive R&D sector, and two primary factors, skilled and unskilled labor. High-tech good is produced from intermediate goods and skilled labor, while low-tech good is produced from intermediate goods and unskilled labor. After paying for a blueprint as a fixed cost, each intermediate good firm produces a variety from skilled and unskilled labor, and sets its price above the marginal cost to earn monopoly profit which just covers the fixed cost. In the R&D sector, firms use skilled labor to produce blueprints for new varieties.[16] Here the Marshallian external economies work: an R&D firm's production experience contributes to all R&D firms' knowledge in a non-appropriable way. This is another market falilure. In this model, the growth effect depends on which sector is protected. Assuming diversification, an import tariff on high-tech (or low-tech) good raises (or lowers) the wage of skilled labor,[17] which in turn decreases (or increases) the demand for skilled labor in the R&D sector and then pulls down (or pushes up) the growth rate. On the other hand, the welfare effect is ambiguous. Starting from free trade, an import tariff on low-tech good improves resource allocation by correcting insufficient incentive for R&D. If the tariff raises the marginal cost of the intermediate good firms, however, efficiency deteriorates due to further decrease in the output of underproduced intermediate goods. The welfare effect depends on which of these two effects dominates the other.

Fung and Ishikawa (1992) model a simplified version of Grossman and Helpman (1991b) to discover the zero-growth equilibrium for some range of initial condition. Their model has two final good sectors, one intermediate good sector, one R&D sector, and (in effect) one primary factor, labor. High-tech good is produced from intermediate

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[16] We can alternatively suppose that each intermediate good firm directly carries out R&D before entry. Both specifications yield the same outcomes.

[17] This is an application of the Stolper-Samuelson theorem.

goods, while low-tech good is produced from labor under decreasing returns. Production of both intermediate goods and blueprints requires only labor. They neglect household behavior by assuming that the interest rate as well as the relative price of final goods is exogenously given in the world market. For R&D to be active, sufficient amount of labor must leave the low-tech sector. Given the relative price, the larger (or smaller) is the number of varieties, the higher (or lower) is the marginal revenue product of labor in the intermediate good sector, and hence the less (or more) labor the low-tech firms employ. If the number of varieties is larger than some critical value in the initial period, the economy experiences growth, during which labor moves from the low-tech to the high-tech and the R&D sectors. Otherwise, the economy can not grow by itself. A production tax on the low-tech sector may make the zero-growth economy take off by releasing labor from that sector.[18]

1.4 Convergence or divergence

Can developing Southern economies catch up with developed Northern economies? The absolute convergence hypothesis is derived from the neoclassical growth theory in a closed economy. It predicts that poor economies tend to grow faster than rich ones, since the former has larger growth potential which is reflected in higher marginal product of capital. As Fig. 1.2 indicates, however, there seems to be no negative correlation between the growth rate and the initial income.

One solution to this difficulty is to modify the concept of convergence. The conditional convergence hypothesis means that "an economy grows faster the further it is from its own steady-state value." (Barro and Sala-i-Martin 1995, pp. 28) Formally, it is expected that the coefficient of the initial income will be significantly negative, after controlling for parameters which characterize the steady-state level of the economy's income. (e.g., saving rate, population growth rate, human capital, etc.) Mankiw et al. (1992) and Sala-i-Martin (1996), among others, get the desired result. It should be noted that this "classical approach to convergence analysis" (named by Sala-i-Martin 1996) rests on the neoclassical growth theory *in a closed economy*. In other words, this approach assumes that the world consists of many isolated economies.[19]

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[18] Ishikawa (1992) gives a perfect competition model with the Marshallian external economies in a producer service sector, which has the same role as the R&D sector in Fung and Ishikawa (1992), and obtains similar results.

[19] Quah (1996) criticizes this approach and sets out an alternative hypothesis that the world income distribution exhibits twin peaks: economies tend to be split into two convergence clubs, rich and

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If we want to explain theoretically how trade in goods and ideas affects convergence between North and South, it is better to formulate the multi-economy endogenous growth models. The following results suggest that whether technology is transferred from North to South, either directly or indirectly, is essential for convergence.

Lucas (1988, Sec. 5) develops a multi-economy model to illustrate the divergence of growth rates across economies. Although his model has a continuum of small economies, we now present its two-economy version. In economy i ($i = N,S$), where N and S represent North and South, respectively, good j ($j = 1,2$) Y_j^i is produced according to

$$Y_j^i = K_j^i u_j^i,$$

where K_j^i and u_j^i denote knowledge and labor demand in sector j, respectively. The labor supply is fixed to unity. It is assumed that K_j^i is external to firms. Knowledge is accumulated through learning-by-doing:

$$\dot{K}_j^i = \delta_j Y_j^i,$$

where δ_j is a productivity parameter which is common to the two economies, and a dot over a variable represents differentiation with respect to time. Suppose that $\delta_1 > \delta_2$: high-tech sector 1 is better at accumulating knowledge than low-tech sector 2. The fact that the increase in knowledge in sector j in economy i depends solely on the output of its own implies that there are neither intersectoral nor international knowledge spillovers. Equalization of the values of marginal product of labor gives the autarky relative price of good 1 to good 2 as $p^i = K_2^i / K_1^i$. If $K_2^N / K_1^N < K_2^S / K_1^S$ in the initial period, North (or South) specializes in good 1 (or 2) with K_1^N (or K_2^S) and hence the output growing at δ_1 (or δ_2). If the two goods are good substitutes for households,

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poor. See Temple (1999) for a survey of the empirical analysis of the convergence issue.

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terms-of-trade movement is moderate enough to leave the initial patterns of specialization unchanged over time.[20] Accordingly, the growth rate of South specializing in low-tech good does not converge to that of North specializing in high-tech good. In this model, the initial conditions determine the patterns of trade and growth which are sustained forever.[21]

Murat and Pigliaru (1998) incorporate international and intersectoral spillovers into Lucas (1988, Sec. 5), and reveal that the presence of international spillovers, if any, leads to convergence. Without international and with intersectoral spillovers, South can not catch up with North, since the former produces low-tech but not high-tech good. If knowledge spills over from high-tech sector in North to low-tech sector in South, however, the growth rate of South necessarily converges to that of North.[22] This is because technological advantage in North directly contributes to technological progress in South.[23]

van de Klundert and Smulders (1996) extend Lucas (1988, Sec. 5) to a three-good model to argue that two economies do not necessarily converge, if the degree of international spillovers is not so large. Each of two economies N and S can produce low-tech good and high-tech good under perfect competition. Low-tech goods of the two economies are perfect substitutes while high-tech goods are imperfect substitutes for households. Knowledge is augmentable only in the high-tech sector and spills over from knowledge-rich North to knowledge-poor South. In South, on the other hand, relative productivity gain due to spillovers worsens the terms of trade between high-tech

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[20] Suppose that the preference of all households in both economies is identical and homothetic. Then we can construct the world representative household whose preference is given by $C_1 / C_2 = p^{-\sigma}$, where C_j and σ denote world consumption of good j and elasticity of substitution, respectively. If σ is large, the rate of change in p is small for a given rate of change in C_1 / C_2.

[21] Young (1991) modifies Lucas (1988, Sec. 5) to a model with a continuum of goods and intersectoral spillovers, and finds that the difference in the growth rates widens after opening trade.

[22] Suppose that the accumulation equation in sector 2 in South is given by $\dot{K}_2^S = \delta_2 Y_2^S + \psi Y_1^N$, where $\psi > 0$ represents the degree of international spillovers. Under specialization, this is rewritten as $\dot{K}_2^S / K_2^S = \delta_2 + \psi K_1^N / K_2^S$. On the other hand, we have $\dot{K}_1^N / K_1^N = \delta_1$. If and only if $K_1^N / K_2^S < (or >)(K_1^N / K_2^S)^* = (\delta_1 - \delta_2)/\psi$, K_1^N / K_2^S increases (or decreases) toward $(K_1^N / K_2^S)^*$.

[23] van Elkan (1996) and Feenstra (1996, Sec. 6.3) also exhibit convergence in the growth rates with international spillovers. In van Elkan (1996), there are two perfectly substitutable types of knowledge, original and imitation, and the original knowledge in each economy spills over to imitation technology in each other. In Feenstra (1996, Sec. 6.3), R&D knowledge in economy i takes the form $K^i = n^i + \psi n^{i'}$, where n^i and $n^{i'}$ denote measure of the number of domestic and foreign varieties, respectively. Convergence emerges as long as ψ is positive.

goods, and hence, knowledge.[24] If the positive spillover effect is dominated by the negative terms-of-trade effect, the growth rate of South diverge from that of North.

Are knowledge spillovers *necessary* for convergence? The answer is No. What is necessary is that the fruit of knowledge expansion in North is distributed to South through international transactions. Devereux and Lapham (1994) introduce initial difference in knowledge to a completely symmetric two-economy R&D model of Rivera-Batiz and Romer (1991), and indicate the convergence property even in the absence of spillovers. Suppose that the production function of final good in economy i ($i = N,S$) is given by

$$Y^i = (\int_0^{n^i} x^i(j)^\alpha \, dj + \int_0^{n^{i'}} x^i(j')^\alpha \, dj')(L_Y^i)^{1-\alpha} ; \alpha \in (0,1),$$

where n^i, $n^{i'}$, $x^i(j)$, $x^i(j')$, and L_Y^i denote measure of the number of domestic varieties, that of foreign, variety $j \in [0, n^i]$ of intermediate good demanded domestically, variety $j' \in [0, n^{i'}]$ of intermediate good imported from foreign, and labor demand, respectively. Assume that the two economies are completely symmetric, except that North has larger stock of knowledge than South in the initial period: $n^N > n^S$. After opening trade in final and intermediate goods,[25] North gets more and more share in the world knowledge, and finally all R&D is done by North. However, it does not imply that South stops growing. To see this, considering the symmetry among varieties, the production functions are rewritten as

$$Y^N = (n^N (\overline{x}^N)^\alpha + \overline{n}^S (\overline{x}^N)^\alpha)(\overline{L}_Y^N)^{1-\alpha},$$

$$Y^S = (n^N (\overline{x}^S)^\alpha + \overline{n}^S (\overline{x}^S)^\alpha)(\overline{L}_Y^S)^{1-\alpha},$$

where a bar over a variable represents that the variable is constant. Both economies grow at the rate of growth in n^N asymptotically.[26] In spite of no R&D, South tends to grow at the same rate as North, because importing increasing varieties of foreign

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[24] In Murat and Pigliaru (1998), van Elkan (1996), and Feenstra (1996, Sec. 6.3), knowledge in two economies is perfect substitutes, so that the terms-of-trade effect mentioned here is zero.

[25] Homogeneous final goods are not traded ex post, since households with identical preferences have no incentive for intertemporal trade.

[26] $\dot{Y}^i / Y^i = \theta^i \dot{n}^N / n^N$, where $\theta^i \equiv n^N (\overline{x}^i)^\alpha / (n^N (\overline{x}^i)^\alpha + \overline{n}^S (\overline{x}^i)^\alpha)$ denotes share of varieties produced in North in the index of intermediate goods. θ^i approaches unity as n^N becomes large.

intermediate goods fosters domestic productivity in the same way as doing R&D by itself.[27]

1.5   Technology transfer

The previous section tells us that technology transfer from North to South is the engine of convergence. There we assume that technology transfer occurs automatically: knowledge spills over with no cost. In this section, we alternatively suppose that technology is transferred through deliberate economic activities. For example, technology originated in North is available in South only after Southern entrepreneurs spend resources to imitate Northern products, Northern firms set up overseas subsidiaries in South, and so on. In this context, the major issue is whether the government(s) should regulate the flow of knowledge. Specifically, is it good for growth to protect intellectual property rights (IPRs)?[28] As we can see from the following paragraphs, the answer depends on whether the agents who transfer technology is encouraged or discouraged by the protection.

Making use of the R&D model of their own developing, Grossman and Helpman (1991c) succeed in endogenizing both innovation and technology transfer by rational agents. They suggest that strengthening IPR protection (i.e., a rise in imitation tax) in South lowers the growth rate. Suppose that North and South are identical, except that the former specializes in innovation while the latter specializes in imitation. Once innovated, each Northern firm keeps monopoly until a Southern imitator succeeds in reverse-engineering the variety and sells the blueprint to a firm, who wins the entire market for that variety because of lower wage. In contrast to the models with international knowledge spillovers, only each economy's own aggregate knowledge stock contributes to innovation or imitation productivity. Let n, n^N, and n^S denote measure of the number of varieties innovated so far in North and consumed worldwide, that still produced in North, and that imitated and now produced in South, respectively. Of course, $n = n^N + n^S$. In the steady state, all of the three variables grow at a constant rate γ, and the rate of imitation $\mu \equiv \dot{n}^S / n^N$ and the share of varieties produced in North $\sigma^N \equiv n^N / n$ are also constant.

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[27] Feenstra (1996, Sec. 6.1) demonstrates the partial convergence property with trade in intermediate as well as final goods and without spillovers.

[28] For practical importance of intellectual property rights, see:
http://www.wto.org/wto/intellec/intellec.htm.

When the effective labor (i.e., labor endowment divided by unit labor requirement in imitation) in South increases, more labor is employed in the imitation sector, so that μ rises. Then what happens in North? We first note that there is a positive relationship between γ and μ in the free entry condition for Northern firms, which requires that the profit rate for each firm be equal to the risk-adjusted interest rate.[29] A rise in μ, *ceteris paribus*, raises the profit rate more than the risk-adjusted interest rate. This is because the profit base of each surviving Northern firm increases due to the exit of some Northern firms.[30] A rise in γ is needed to restore equilibrium: the profit rate falls and the risk-adjusted interest rate rises. Since γ and μ are positively related, γ rises as a result of an increase in the effective labor in South. Strengthening IPR protection has the same effect as a decrease in the effective labor in South by raising the cost of imitation.[31]

Applying a similar framework to Grossman and Helpman (1991c), Lai (1998) argues that tightening IPR protection in South raises the growth rate, if it is Northern multinational corporations (MNCs) rather than Southern imitators that transfer technology from North to South. Each Northern firm has two options of production location. If it operates domestically, its monopoly position is secured by patent laws, but it has to endure higher wage. If it goes multinational, it enjoys lower wage, but it faces the risk of being imitated by Southern firms. The returns to these two options are equalized in equilibrium. On the other hand, Southern firms imitate the MNCs' varieties at an exogenous rate, and on succeeding in imitation, they compete in prices to drive out the MNCs. Suppose that IPR protection is tightened, that is, the rate of imitation is lowered. Then Northern firms have greater incentive to go to South than to stay North, so that the rate of technology transfer rises. Since there is complementarity between

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[29] The free entry condition is given by $\dfrac{1-\alpha}{\alpha}\dfrac{L^{N}/a_{D}-\gamma}{\sigma^{N}}=\gamma+\rho+\mu$, where L^{N}, a_{D}, and ρ denote labor endowment in North, unit labor requirement in innovation, and subjective discount rate, respectively. The left-hand side represents the profit rate, while the right-hand side represents the risk-adjusted interest rate.

[30] We have $\sigma^{N}=n^{N}/(n^{N}+n^{S})=(1+n^{S}/n^{N})^{-1}$. In the steady state, n^{S}/n^{N} is calculated as $n^{S}/n^{N}=(n^{S}/\dot{n}^{S})(\dot{n}^{S}/n^{N})=\mu/\gamma$. Hence, we get $\sigma^{N}=(1+\mu/\gamma)^{-1}=\gamma/(\gamma+\mu)$. This implies that a rise in μ decreases σ^{N}. Given n and $X^{N}\equiv n^{N}x^{N}$, where X^{N} and x^{N} denote total output and per-firm output in North, respectively, n^{N} decreases while x^{N} increases. A rise in γ has the opposite effects.

[31] Lai (1995) replaces constant-returns technology in producing each variety with decreasing-returns one by adding one specific factor, and implies similar outcomes. Grossman and Helpman (1991d) formulate an alternative R&D model with rising product quality, and suggest similar results when Northern innovators target their effort on only varieties currently produced by Southern firms.

innovation and technology transfer for Northern firms, as in Grossman and Helpman (1991c), the rate of innovation also rises.[32]

1.6   Introduction to the following chapters

The following two chapters are original contributions to the literature on the first question raised in section 1.1: how does trade policy affect growth and welfare? They shed light on why the HPAEs perform better than the other developing economies by taking some forms of trade policy.

Two facts about trade policy in the HPAEs deserve attention. First, the fastest-growing economies are far from free trade. Fig. 1.3 plots the average annual growth rates of the real per-capita GDP of 41 economies between 1988 and 1992 against the logarithmic values of one plus the import-weighted tariff rate in 1988.[33] According to this figure, there is no correlation between the growth rate and the tariff rate. If we pick out the HPAEs, however, we find the positive correlation between them. Especially, the second to the fourth fastest growing economies in the sample are Korea (8.57%; 1988-1991), Malaysia (7.45%), and Thailand (7.06%), all of whom imposed tariffs of the rate more than 10%. (16.8%, 11.7%, and 35.2%, respectively.) Why did these economies grow faster than the other developing economies, both of whom were heavily distorted by tariffs? Chapter 2 tries to answer this question. If the government spends the tariff revenue for correcting insufficient incentive for capital demand due to externality, imposing tariffs results in higher growth rate and welfare than in free trade.

Second, the HPAEs have experienced gradual trade liberalization. The World Bank (1993, Chap. 6, Sec. 4) reports the evidence that most governments in the HPAEs protected some sectors at first, and thereafter have been reducing the degree of protection little by little. Some researchers argue that the success of the HPAEs are

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[32] The free entry condition for Northern firms is given by $\dfrac{1-\alpha}{\alpha}\dfrac{L^N/a_D - \gamma}{\sigma^N} = \gamma + \rho$;

$\sigma^N = \gamma/(\gamma + v)$, where v denotes the rate of technology transfer carried out by MNCs. Note that this is the same as the free entry condition in Grossman and Helpman (1991c), except that here the risk premium does not directly appear in the right-hand side. The risk premium actually appears in the no-arbitrage condition between the returns to domestic production and multinationalization. We can derive the positive relationship between γ and v by the same logic as in Grossman and Helpman (1991c).

[33] Source: growth rate: Summers and Heston (1994); tariff rate: Lee and Swagel (1997). Data of Taiwan is absent in the latter.

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thanks to their outward-oriented trade policy. Then why were they not outward-oriented from the beginning? Why did trade liberalization proceed gradually? Chapter 3 attempts to tackle these questions. Sufficient amount of protection in the initial period releases the economy from the poverty trap, while sustained growth enables the government to reduce the degree of protection gradually. The minimum-protection type of gradual trade liberalization is the optimal trade policy from the viewpoint of households.

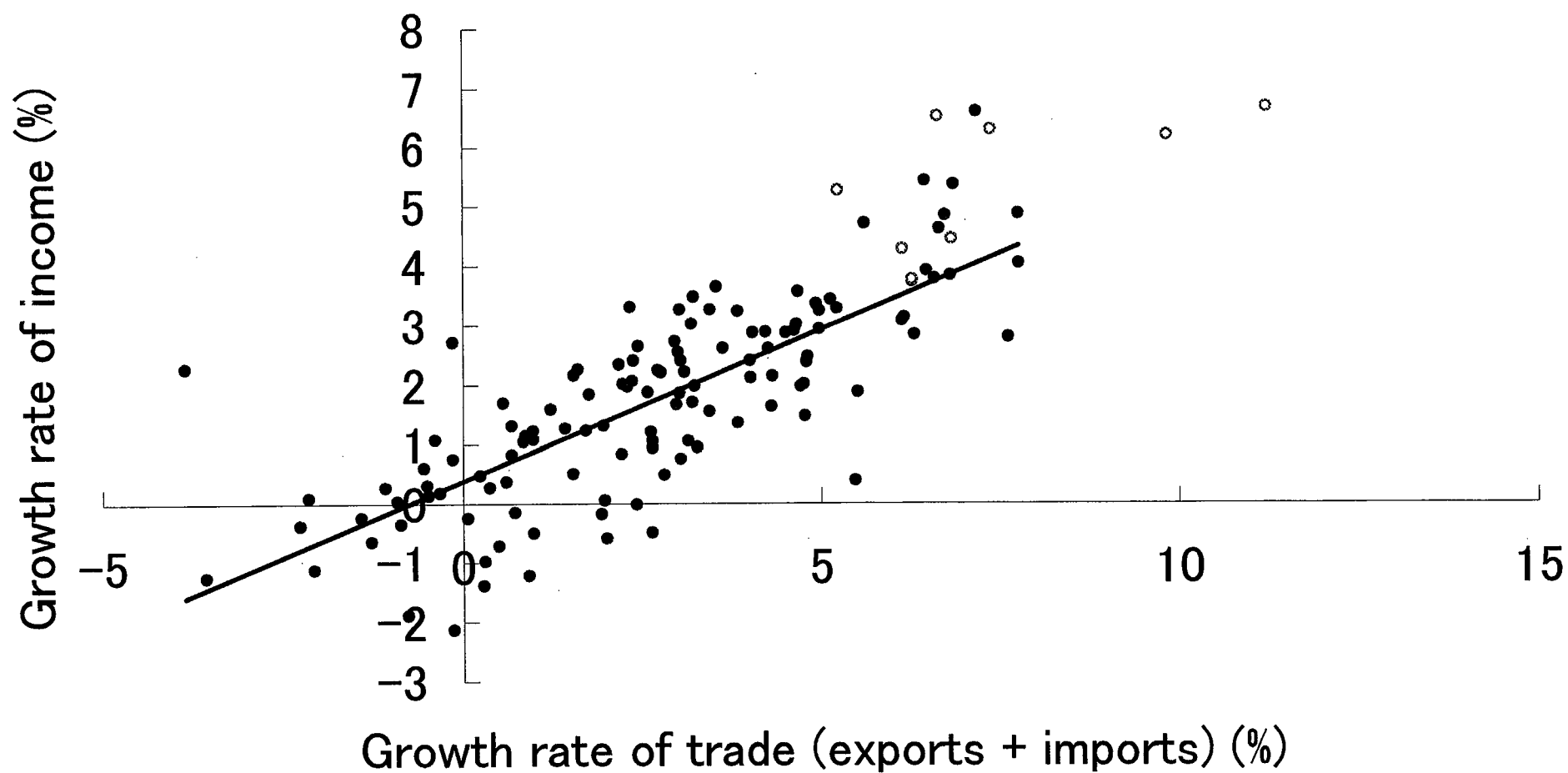Fig. 1.1. Growth of trade and income, 1960–1990 (open circle: HPAE)

Fig. 1.2.　Convergence, 1960–1990
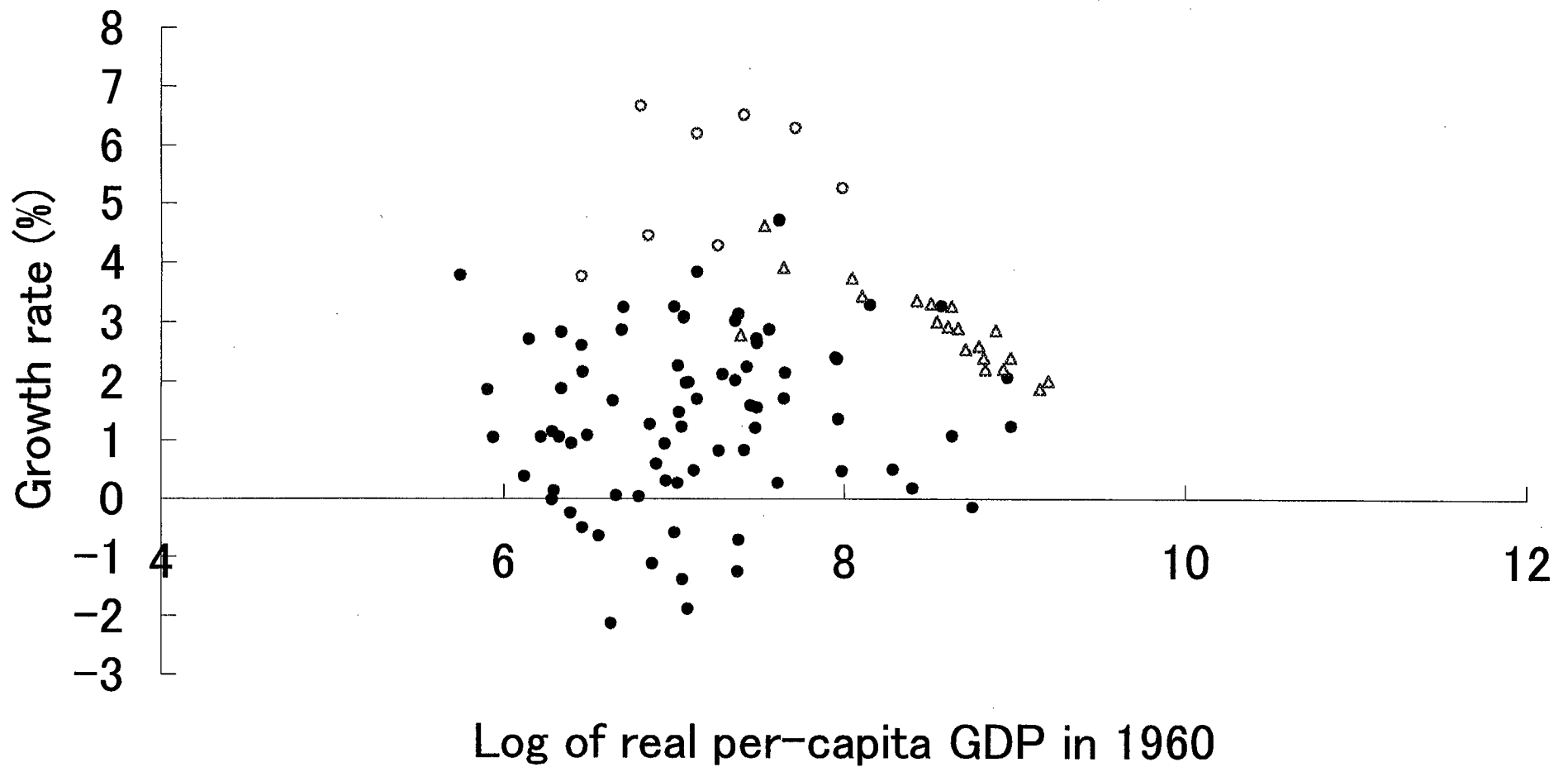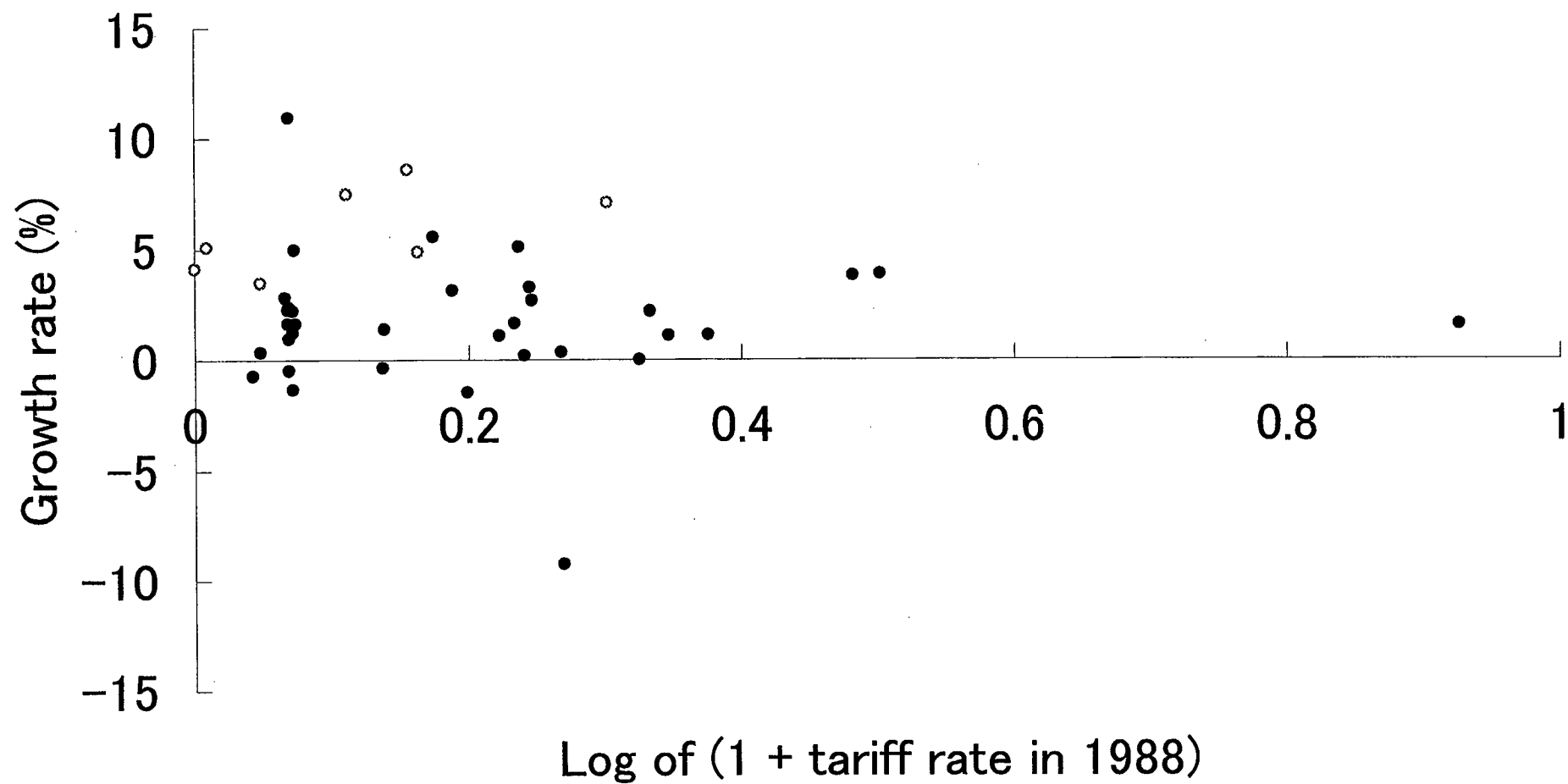(open circle: HPAE; open triangle: OECD)

Fig. 1.3. Tariffs and growth, 1988–1992
(open circle: HPAE)

2 Tariff revenue, government expenditure and growth in a small open economy

2.1 Introduction

It is widely known that tariff revenue takes a non-negligible part of government revenue in developing economies. According to IMF's *Government Finance Statistics Yearbook 1996,* more than 20% of the government revenue relies on trade taxes in nearly 40% of the developing economies. This fact helps us to emphasize that tariffs be seen not only as the source of distortion but as the source of government revenue. On the other hand, the role of government policy on growth performance has been attracting the attention of development economists, and thoroughly analyzed in many types of endogenous growth models in recent years.[1] It is known that the government should be active if and only if the intervention can correct the distortion inherent in the economy.

Then how does the government intervention affect growth and welfare in a small open economy? Lee (1993) constructs a small-open neoclassical growth model with a lump-sum transfer to households as the only direction of government expenditure, and claims that any trade intervention can not accelerate growth and improve welfare.[2] Osang and Pereira (1996) develop a small-open endogenous growth model with physical and human capital, and get a welfare implication similar to Lee's under an investment tax credit (i.e., subsidy) in addition to the lump-sum transfer. However, their conclusions depend on the absence of some domestic distortion. What happens if the tariff revenue is used for correcting the distortion? Another point to note is that the tariff revenue is just one way of financing the anti-distortionary government expenditure. If the government finds another potential source of revenue, it must be compared with the tariff. Here a lump-sum tax will be adopted so that the market economy should attain the Pareto optimal allocation. What is the difference between the two financing measures? The purpose of this paper is to present a small-open endogenous growth model to answer these questions.

The model in this paper extends Lee (1993): learning-by-doing effect is incorporated in domestic intermediate good sector.[3] Including the Marshallian external

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[1] Barro and Sala-i-Martin (1995) provide an excellent survey of the field.

[2] Lee (1995) extends Lee (1993) to the Rebelo (1991)-type two-sector framework.

[3] Romer (1986) pioneers an endogenous growth model through learning-by-doing.

economies dramatically alters the implications of the model. First, a deviation from free trade pushes up the growth rate and improves the welfare, if the tariff revenue is used for correcting the domestic distortion. Second, provided that domestic and foreign intermediate goods are substitutes, the growth rate with tariff is lower than that with lump-sum tax, so is the welfare.

The rest of this paper is organized as follows. Section 2.2 sets up the model. Section 2.3 analyzes the usual case of tariff with lump-sum transfer, and obtains the free trade principle. Section 2.4 deals with the situation in which the tariff revenue finances the anti-distortionary subsidy. Section 2.5 evaluates the growth-maximizing and the optimal allocations in section 2.4 in the light of the Pareto-optimal allocation, which is replicated by the subsidy financed by the lump-sum tax. Section 2.6 concludes.

2.2   The model

Consider a small open economy which has one final good sector Y (the numeraire) and one intermediate good sector X. A number of firms in sector Y have an access to identical production function of domestic intermediate good and foreign intermediate good M. The domestic intermediate good is produced by a number of firms with identical production function of capital and effective labor. The effectiveness of labor is represented by economy-wide capital-labor ratio. The individual firms in sector X ignore their own contribution to the capital-labor ratio, and take it as given. Labor is identified with population, and constant. The foreign intermediate good is supplied in a perfectly elastic manner at a given price. A number of identical households supply asset as loan service to one another, as capital service to firms, and labor service to firms, in return for interest, rental, and wage. From the flow of their income, the households consume the final good, or accumulate the asset. No international borrowing and lending are allowed.

In the aggregate, firms in sector X face the production function of the form

$$X(t) = G(K(t), E(t)L(t)),$$

where K, E, and L denote capital, effectiveness of labor, and labor.[4] It is assumed that $G(\cdot)$ has positive and diminishing marginal products and exhibits constant returns to

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[4] Once stated, time variable t is omitted unless it causes some confusion.

scale. Dividing both sides by L, the production function is expressed in per-capita form:

$$x = G(k,E); x \equiv X/L, k \equiv K/L.$$

The effectiveness of labor is given by[5]

$$E(t) = k(t). \qquad (2.1)$$

Let $p_X(t)$, $R(t)$, and $w(t)$ denote price of X, rental, and wage, respectively. The firms maximize their profits, given p_X, R, w, and E. The first-order conditions (FOCs) are

$$R = p_X G_1(k,E), \qquad (2.2)$$

$$w = p_X(G(k,E) - kG_1(k,E)), \qquad (2.3)$$

where a subscript number represents differentiation with respect to the number[th] argument. The right-hand sides of (2.2) and (2.3) express VMP_K and VMP_L, values of marginal product of capital and labor, respectively.

Firms in sector Y are subject to the following production function:

$$Y(t) = F(X(t), M(t)),$$

where $F(\cdot)$ has positive and diminishing marginal products and exhibits constant returns to scale. Dividing both sides by X, we have

$$Y/X = F(1, M/X)$$
$$= f(q); q \equiv M/X.$$

q is interpreted as relative intensity of foreign intermediate good to domestic one. With $p_M(t)$ denoting price of M, the firms maximize their profits, given p_X and p_M. The FOCs are

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[5] Alternatively, $E(t) = K(t)$ is possible. Although this specification will yield qualitatively the same results, it causes the economy with larger population to enjoy higher growth rate. The specification such as (2.1) avoids this kind of scale effect.

$$p_X = f(q) - qf'(q),$$ (2.4)

$$p_M = f'(q).$$ (2.5)

The right-hand sides of (2.4) and (2.5) express VMP_X and VMP_M, values of marginal product of domestic intermediate good and foreign intermediate good, respectively.

The budget constraint of households in the aggregate is given by

$$\dot{A}(t) = r(t)A(t) + w(t)L - C(t) + T(t),$$

where A, r, C, and T denote stock of asset, interest on loans, consumption, and lump-sum transfer from the government (negative T refers to lump-sum tax), and a dot over a variable represents differentiation with respect to t. Its per-capita form is

$$\dot{a} = ra + w - c + T/L; a \equiv A/L, c \equiv C/L.$$ (2.6)

The utility of the representative household is defined as

$$U = \int_0^\infty e^{-\rho t}(c(t)^{1-\theta} - 1)/(1-\theta)dt; \rho > 0, \theta > 0,$$

where ρ and θ denote subjective discount rate and elasticity of marginal utility, respectively. In the present case with no uncertainty, θ is just the inverse of elasticity of intertemporal substitution. The households maximize the utility, subject to (2.6), given $a(0)$, $\{r(t)\}_{t=0}^\infty$, and $\{w(t)\}_{t=0}^\infty$. The usual Hamiltonian method yields

$$e^{-\rho t}c(t)^{-\theta} - v(t) = 0,$$ (2.7)

$$v(t)r(t) = -\dot{v}(t),$$ (2.8)

where v denotes value of a unit of final good measured in terms of utility at $t = 0$, as the FOCs, and

$$\lim_{\bar{t}\to\infty} v(\bar{t})a(\bar{t}) = 0,$$ (2.9)

as the transversality condition. The Euler equation is derived from (2.7) and (2.8) as

$$\dot{c}(t)/c(t) = (1/\theta)(r(t) - \rho).$$ (2.10)

The asset market is described as follows. There are two perfectly substitutable assets, the claim of loans and the ownership of capital. The no-arbitrage condition between the two assets is[6]

$$r = R.$$ (2.11)

Since the two assets are perfect substitutes, the demand for them can be simply summed. From the fact that the aggregate net demand for loans is zero in equilibrium, the asset market clearing condition must be given by

$$A = K.$$ (2.12)

2.3 Regime 1: import tariff with lump-sum transfer

Consider first the case of free trade as a benchmark. Suppose that $p_M^f = 1$, where the superscript f stands for "free trade."[7] From (2.5), q in free trade is given by

$$q = f'^{-1}(1) \equiv q^f.$$

Substituting this into (2.4), p_X in free trade is expressed as

$$p_X = f(q^f) - q^f f'(q^f) \equiv p_X^f.$$

Suppose next that the government imposes an ad-valorem tariff of the rate τ, and redistributes the tariff revenue to households in a lump-sum fashion. It is assumed throughout that τ is given in the initial period, and can not be changed thereafter. Then the domestic price of M is given by $p_M = 1 + \tau$. Throughout this paper, suppose that $\tau \geq 0$. Assuming balanced budget in every period, the government's budget constraint is

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[6] We assume that capital does not depreciate at all. This will not alter the qualitative results.

[7] This normalization is done only for simplicity. The following results will not be essentially changed as long as any arbitrary constant is set for the free-trade import price.

$$T = \tau M.\qquad(2.13)$$

From (2.5), q in general is given by

$$q = f'^{-1}(1 + \tau) \equiv q(\tau); q' = 1/f'' < 0.$$

Then from (2.4), p_X in general is expressed as[8]

$$p_X = f(q(\tau)) - q(\tau)f'(q(\tau)) \equiv \varphi(\tau); \varphi(0) = p_X^f, \varphi' = -q < 0, \varphi'' = -q' > 0.$$

For p_X to be positive, it is assumed that

$$\varphi(\tau) > 0.\qquad(2.14)$$

Substituting the above expression for p_X into (2.2), and considering (2.1), we get

$$R = B_1\varphi(\tau); B_1 \equiv G_1(1,1).\qquad(2.15)$$

The kind of equation such as (2.15) is named the VMP_K equation, and is often mentioned in the rest of this paper. It is easily seen that R monotonically falls with τ. See Fig. 2.1 through Fig. 2.3. A rise in τ reduces the employment of M in Fig. 2.1, shifting the negatively-sloped VMP_X schedule down in Fig. 2.2. With the supply of X unchanged,[9] it brings p_X down. In Fig. 2.3, the negatively-sloped *private* VMP_K schedule is lowered proportionately with p_X, causing R to go down. w is calculated in the same manner as (2.15):[10]

$$w = B_2\varphi(\tau)k; B_2 \equiv G_2(1,1).$$

It is time to find the equilibrium path. The resource constraint is derived from (2.6),

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[8] In deriving that $\varphi' = -q$, we have used the fact that $q' = 1/f''$.

[9] Look first at Fig. 2.3. For any p_X, the equilibrium quantity of demand for K is equal to the fixed quantity of supply. Since X is linear in K, the supply schedule of X is vertical against the X-axis in Fig. 2.2.

[10] Euler's formula is applied in deriving this expression.

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(2.11), (2.12), (2.13), and the expressions for R and w, as

$$\dot{k} = B(\varphi(\tau) - \tau\varphi'(\tau))k - c; B \equiv G(1,1) = B_1 + B_2. \tag{2.16}$$

The growth rate of consumption is derived from (2.10), (2.11), and (2.15) as

$$\dot{c}/c = (1/\theta)(B_1\varphi(\tau) - \rho). \tag{2.17}$$

Given τ, (2.16) and (2.17) fully describe the dynamic behavior of the economy. It follows that k also grows at the constant rate $\dot{c}/c$ from the initial period to the infinite horizon, implying that the economy is always in the steady state.[11] From the production function of X and the fact that p_X is constant, gross domestic product (GDP) $p_X X$ [12] must also grow at the same rate. So let $\gamma^1(\tau)$ denote the common steady-state growth rate. Throughout this paper, a superscript number represents the regime the economy is in. Differentiating (2.17) with respect to τ, we have

$$\gamma_\tau^1 = B_1\varphi'/\theta < 0.$$

This says that increasing the tariff rate monotonically lowers the growth rate. Here the only effect of the tariff on the growth rate is the *distortionary effect*.

Once it is known that the free trade policy maximizes the growth rate, it has to be checked whether it also maximizes the welfare. Noting that $c(t)$ grows at a constant rate γ, the utility of the representative household is rewritten as

$$U = \frac{1}{1-\theta}\left[\frac{c(0)^{1-\theta}}{\rho - \gamma(1-\theta)} - \frac{1}{\rho}\right].$$

It is assumed that

$$\rho > \gamma(1-\theta), \tag{2.18}$$

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[11] This is a typical feature of the AK models with only one state variable: the transversality condition excludes any transitional dynamics. See Barro and Sala-i-Martin (1995, pp. 142-143) for rigorous proof.

[12] The value of total output is $Y + p_X X$. However, all the value of the final good is paid to foreigners and firms in sector X. Therefore, the GDP is $p_X X$.

in order to exclude unbounded utility. For $\theta = 1$, applying l'Hopital's rule yields

$$U = (1/\rho)(\gamma/\rho + \ln c(0)).$$

From (2.16) and the fact that $\dot{k}/k = \gamma^1(\tau)$, the consumption function in the initial period is given by

$$c^1(0) = [B(\varphi(\tau) - \tau\varphi'(\tau)) - \gamma^1(\tau)]k(0).$$

Substituting this into the utility function and differentiating it with respect to τ, we get

$$\Delta^1 U_\tau^1 = -B\tau\varphi''[\rho - \gamma^1(1-\theta)] - \gamma_\tau^1[\rho - \gamma^1(1-\theta)] + \gamma_\tau^1[B(\varphi - \tau\varphi') - \gamma^1];$$

$$\Delta^1 \equiv [\rho - \gamma^1(1-\theta)]^2 c(0)^\theta k(0)^{-1}.$$

In the right-hand side of this expression, the first term reflects the *income-reducing effect* of the tariff, meaning that the flow of income belonging to the economy decreases through the decrease in q. On the other hand, the second and the third terms indicate the indirect and the direct effects of the change in γ^1, respectively: a rise in the growth rate indirectly lowers the welfare through the decrease in the initial consumption, while it directly raises the welfare by increasing the future consumption. Combining the last two terms and using (2.17), we have

$$\Delta^1 U_\tau^1 = -B\tau\varphi''[\rho - \gamma^1(1-\theta)] + \gamma_\tau^1(B_2\varphi - B\tau\varphi').$$

This implies that U_τ^1 is globally negative, since γ_τ^1 is globally negative. In other words, increasing the tariff rate monotonically lowers the welfare.

To sum up,

Proposition 2.1.   In Regime 1, free trade is both growth-maximizing and optimal.

2.4   Regime 2: import tariff with capital subsidy

Suppose that the government sets an ad-valorem subsidy of the rate $s \in [0,1)$ to

the employment of capital service, which is financed by the tariff.[13] Then (2.15) is modified to

$$(1-s)R = B_1\varphi(\tau).$$

The government's budget constraint is

$$sRK = \tau M. \tag{2.19}$$

Taking account of (2.19), the VMP_K is expressed as

$$R = B_1\varphi(\tau) - B\tau\varphi'(\tau). \tag{2.20}$$

Using (2.20) and the calculated expression for w, the resource constraint and the growth rate are respectively given by

$$\dot{k} = B(\varphi(\tau) - \tau\varphi'(\tau))k - c, \tag{2.21}$$

$$\gamma^2(\tau) = (1/\theta)(B_1\varphi(\tau) - B\tau\varphi'(\tau) - \rho). \tag{2.22}$$

Note that the resource constraint in Regime 2 (2.21) is the same as that in Regime 1 (2.16). It is easy to verify that in free trade (2.21) and (2.22) yield the same allocation as the growth-maximizing and the optimal one in Regime 1.

First, let us explore the growth-maximizing tariff rate. Differentiating (2.22) with respect to τ, we have

$$\gamma_\tau^2 = (B_1\varphi' - B\varphi' - B\tau\varphi'')/\theta.$$

The first term in the right-hand side reflects the distortionary effect, which was also present in Regime 1. The second and the third terms indicate the productivity effects of the subsidy financed by the tariff. The second term, which we call the *productivity-enhancing effect,* is positive due to the increase in the tariff revenue for given q, while the third term, the *productivity-reducing effect,* is negative because the tariff revenue decreases as a result of the fall in q. Note that the productivity-enhancing effect

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[13] s is assumed to be permanent as well as τ.

outweighs the distortionary effect. This is because the social marginal product of capital B is larger than the private marginal product of capital B_1.

Evaluating γ_τ^2 at $\tau = 0$, the second-order productivity-reducing effect vanishes, so that $\gamma_\tau^2(0) > 0$. In other words, a small deviation from free trade raises the growth rate. On the other hand, the FOC of maximization of $\gamma^2(\tau)$ is

$$\gamma_\tau^2(\tau) = 0. \tag{2.23}$$

Assume that the solution to (2.23) exists and is unique. This can be analytically proved when $G(\cdot)$ is of the Cobb-Douglas form and $F(\cdot)$ is of the CES form, as specified later in this section. See Appendix 2A for proof. Let $\hat{\tau}^2$ denote the solution.

Proposition 2.2. *In Regime 2, the growth-maximizing tariff rate is positive.*

The next thing to consider is what is the optimal tariff rate. In the same way as in Regime 1, the welfare effect is decomposed into

$$\Delta^2 U_\tau^2 = -B\tau\varphi''[\rho - \gamma^2(1-\theta)] - \gamma_\tau^2[\rho - \gamma^2(1-\theta)] + \gamma_\tau^2[B(\varphi - \tau\varphi') - \gamma^2];$$

$$\Delta^2 \equiv [\rho - \gamma^2(1-\theta)]^2 c(0)^\theta k(0)^{-1}.$$

Using (2.22), this is calculated as

$$\Delta^2 U_\tau^2 = -B\tau\varphi''[\rho - \gamma^2(1-\theta)] + \gamma_\tau^2 B_2\varphi.$$

Evaluating this at $\tau = 0$, the first term in the right-hand side, the income-reducing effect, disappears, so that the sign of $U_\tau^2(0)$ corresponds with that of $\gamma_\tau^2(0)$, which is positive. This says that a small deviation from free trade improves the welfare. On the other hand, for $\tau \geq \hat{\tau}^2$, the second term is negative as well as the first term. Therefore, the optimal tariff rate τ^{2*} lies strictly between zero and $\hat{\tau}^2$.

Proposition 2.3. *In Regime 2, the optimal tariff rate is positive and lower than the growth-maximizing tariff rate.*

Proposition 2.3 says that growth and welfare are rival policy objectives. This is because of the income-reducing effect: the tariff affects the welfare not only through the

growth rate but also through the flow of income. Barro (1990, Sec. 1) gives an endogenous growth model in which revenue from a proportional income tax is spent for publicly provided production services, and proves that the growth-maximizing tax rate is also optimal when production function is of the Cobb-Douglas form. Our proposition is in contrast to Barro's equivalence result, even if the production functions are of the Cobb-Douglas form.[14]

Finally, let us make some numerical examples so as to grasp a concrete image of the model. Following Lee (1993), let

$$X = G(K,EL) = BK^\alpha (EL)^{1-\alpha}; \alpha \in (0,1), \qquad (2.24)$$

$$Y = F(X,M) = [(1 - \lambda_M)X^{(\sigma-1)/\sigma} + \lambda_M M^{(\sigma-1)/\sigma}]^{\sigma/(\sigma-1)}; \lambda_M \in (0,1), \sigma > 0, \quad (2.25)$$

where σ denotes elasticity of substitution between X and M. For $\sigma = 1$, applying l'Hopital's rule yields

$$Y = F(X,M) = X^{1-\lambda_M} M^{\lambda_M}.$$

Under these specifications, p_X is given by

$$p_X = \varphi(\tau) = (1 - \lambda_M)^{\sigma/(\sigma-1)}[1 - \lambda_M^\sigma (1+\tau)^{1-\sigma}]^{1/(1-\sigma)}.$$

(2.14), the condition for positive p_X, is equivalent to

$$1 - \lambda_M^\sigma (1+\tau)^{1-\sigma} > 0. \qquad (2.26)$$

(2.23), the FOC of maximization of $\gamma^2(\tau)$, is equivalent to

$$\psi(\tau) = 0; \psi(\tau) \equiv (1 - \alpha)(1+\tau)[1 - \lambda_M^\sigma (1+\tau)^{1-\sigma}] - \sigma\tau. \qquad (2.27)$$

---

[14] Barro (1990, Sec. 5) presents a counterexample by himself in a setting where the government provides not only production but also consumption services. The reason for the non-equivalence outcome is easy to understand: there are two independent policy variables, tax rates for production and consumption services, and the government takes the latter as given when it maximizes the growth rate. Contrary to this, our model makes the non-equivalence result even if it has only one independent policy variable as well as Barro (1990, Sec. 1).

The following figures are drawn with $B = 0.5$, $\alpha = 0.5$, $\lambda_M = 0.5$, $\rho = 0.01$, $\theta = 1$ (log utility), and $k(0) = e$. Fig. 2.4a and Fig. 2.4b display the dependence of the growth rate and the welfare, respectively, on the tariff rate with $\sigma = 2$. Fig. 2.5a and Fig. 2.5b do with $\sigma = 1$, and Fig. 2.6a and Fig. 2.6b with $\sigma = 0.5$. All of these figures are consistent with the analytical results developed earlier. Several points should be especially noted. First, the higher σ is, the flatter the curves are. This is because the economy adjusts to changes in the tariff rate easily when it has high substitutability. Second, $\hat{\tau}^2$ is not monotonic with σ. Direct calculations from (2.27) reveal that it is $1/4 = 25\%$ when $\sigma = 2$, $1/3 \approx 33\%$ when $\sigma = 1$, and $2^{1/3} - 1 \approx 26\%$ when $\sigma = 0.5$. To see why, applying implicit function theorem in (2.27), we have

$$d\tau / d\sigma \big|_{\psi(\tau)=0} = -\psi_\sigma / \psi'; \psi_\sigma = -(1-\alpha)(1+\tau)\lambda_M^\sigma (1+\tau)^{1-\sigma}[\ln \lambda_M - \ln(1+\tau)] - \tau.$$

Since $\psi'(\hat{\tau}^2) < 0$ because of the fact that $\psi(0) > 0$ and that $\hat{\tau}^2$ is unique, the sign of the left-hand side corresponds with that of ψ_σ, which is ambiguous. Third, Proposition 2.3 is surely supported by the examples. It is estimated that τ^{2*} is about 21% when $\sigma = 2$, about 26% when $\sigma = 1$, and about 20% when $\sigma = 0.5$, each of which is lower than $\hat{\tau}^2$.

2.5 Evaluating Regime 2

To identify the Pareto optimal allocation, suppose first that the government directly allocates the economy's resources to maximize the utility of the representative household. From the expenditure side, the national account of the final good is given by

$$Y(t) = C(t) + \dot{K}(t) + Z(t),$$

where Z denotes export. Note that the foreign good can neither be consumed nor invested. Since international borrowing and lending are not allowed, the current account must be zero, that is,

$$Z = M.$$

From these and (2.1), the resource constraint is derived as

$$\dot{k} = (f(q) - q)Bk - c. \tag{2.28}$$

Note that (2.28) applies to any regime.[15]

The problem is to maximize the utility, subject to (2.28), given $k(0)$. Set up the present-value Hamiltonian as

$$J \equiv e^{-\rho t}(c(t)^{1-\theta} - 1)/(1 - \theta) + \eta(t)[(f(q(t)) - q(t))Bk(t) - c(t)],$$

where η denotes present-value shadow price of a unit of final good. The FOCs are

$$J_c = e^{-\rho t}c(t)^{-\theta} - \eta(t) = 0, \tag{2.29}$$

$$J_q = \eta(t)(f'(q(t)) - 1)Bk(t) = 0, \tag{2.30}$$

$$J_k = \eta(t)(f(q(t)) - q(t))B = -\dot{\eta}(t). \tag{2.31}$$

The transversality condition is

$$\lim_{\bar{t} \to \infty} \eta(\bar{t})k(\bar{t}) = 0. \tag{2.32}$$

Let us find the solution. Note that (2.30) yields $q = q^f$, and

$$f(q^f) - q^f f'(q^f) = p_X^f.$$

Then from (2.29) and (2.31), we get

$$\gamma^{so} = (1/\theta)(Bp_X^f - \rho),$$

---

[15] (2.16) and (2.21), the resource constraints in Regime 1 and Regime 2, respectively, can be derived from the expenditure-side national account, the balanced current account, and the following distribution-side national account:

$$Y(t) = p_X(t)X(t) + p_M(t)M(t)$$
$$= R(t)K(t) + w(t)L + (1 + \tau)M(t).$$

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where the superscript *so* stands for "social optimum." Consumption in the initial period is calculated as

$$c^{so}(0) = (Bp_X^f - \gamma^{so})k(0).$$

Since the instantaneous utility function is strictly concave, the Pareto optimal consumption allocation $\{c^{so}(t)\}_{t=0}^{\infty}$ is unique.

Next, suppose that the government sets the capital subsidy which is financed by a lump-sum tax imposed on households. Let us call this policy environment Regime 3. With the subsidy and no tariff, the VMP_K equation is given by

$$R = [1/(1-s)]B_1 p_X^f.$$

(2.33)

The government's budget constraint is

$$sRK = -T.$$

(2.34)

Then the economy's resource constraint and the growth rate are respectively given by

$$\dot{k} = Bp_X^f k - c,$$

(2.35)

$$\gamma^3(s) = (1/\theta)\{[1/(1-s)]B_1 p_X^f - \rho\}.$$

(2.36)

If the government sets the subsidy rate as

$$s = 1 - B_1/B \equiv s^{3*},$$

(2.37)

then (2.35) and (2.36) give

$$\gamma^3(s^{3*}) = (1/\theta)(Bp_X^f - \rho) = \gamma^{so}.$$

Since the resource constraints and the growth rates are the same, with (2.37) the economy attains the Pareto optimal allocation in Regime 3.

Now it is time to consider whether the maximum welfare or the maximum growth rate in Regime 2 is lower than the maximum welfare or the optimal growth rate in Regime

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3. First, comparing the levels of the optimal initial consumption, we have

$$c^{2*}(0) = [B(\varphi(\tau^{2*}) - \tau^{2*}\varphi'(\tau^{2*})) - \gamma^2(\tau^{2*})]k(0)$$
$$\neq (Bp_X^f - \gamma^3(s^{3*}))k(0) = c^{3*}(0),$$

which is sufficient to say that the maximum welfare in Regime 2 is lower than that in Regime 3. Second, comparing the VMP_K 's, we can not tell if the maximum growth rate is in general lower than the optimal one in Regime 3. By specifying functional forms, however, we can say more.

Proposition 2.4. *Suppose that the production functions are specified as (2.24) and (2.25). The maximum growth rate in Regime 2 is lower than the optimal growth rate in Regime 3, if* $\sigma \geq 1$.

Proof. See Appendix 2B.

If the elasticity of substitution is high in Regime 2, q decreases drastically as the tariff rate rises. Then the amount of the subsidy must be kept low according to the government's budget constraint. In our terms, the productivity-reducing effect is large relative to the net effect of the productivity-enhancing and the distortionary effects. Thus, even the maximum growth rate is not so different from that in free trade. This interpretation is graphically confirmed by Fig. 2.4a.

2.6 Concluding remarks

This paper has investigated policy effects on growth and welfare of a small open economy with domestic distortion. In Regime 1, where tariff revenue is transferred to households, free trade is both growth-maximizing and optimal. In Regime 2, where the tariff revenue is used for correcting the domestic distortion, free trade is neither growth-maximizing nor optimal. Furthermore, the optimal tariff rate is lower than the growth-maximizing one. In Regime 3, where the anti-distortionary government expenditure is financed by a lump-sum tax, the economy can reach the Pareto optimal allocation. Regime 2 is dominated by Regime 3 with respect to both growth and welfare, if domestic and foreign intermediate goods are substitutes.

These results have some policy implications. First, spending policy of the

government is crucial in determining the success of the trade intervention. This view may help explain the difference between the East Asian economies and the other developing economies. Second, even if the trade intervention works in offsetting the domestic distortion, it must be remembered that there is a better revenue source than the tariff. As the economy develops, the government should seek for less distortionary revenue structure for the sake of households.

Appendix 2A   Proof of the existence and the uniqueness of the solution to (2.23) in a specified case

When the production functions are specified as (2.24) and (2.25), (2.23) is equivalent to

$$\psi(\tau) = 0; \psi(\tau) \equiv (1-\alpha)(1+\tau)[1-\lambda_M^\sigma(1+\tau)^{1-\sigma}] - \sigma\tau. \tag{2.27}$$

$\psi(\tau)$ is continuous in τ, and

$$\psi(0) = (1-\alpha)(1-\lambda_M^\sigma) > 0.$$

If

$$\psi(\tilde{\tau}) < 0, \tag{2A.1}$$

then from the intermediate value theorem, there exists $\tau \in (0, \tilde{\tau})$ such that it satisfy (2.27). Therefore, what has to be shown is that (2A.1) holds somewhere at $\tilde{\tau}$.

If $\sigma \geq 1$, we have with $\tilde{\tau} = \infty$,

$$\lim_{\tau \to \infty} \psi(\tau) = \lim_{\tau \to \infty} \left\{ (1-\alpha)[1-\lambda_M^\sigma(1+\tau)^{1-\sigma}] + \{(1-\alpha)[1-\lambda_M^\sigma(1+\tau)^{1-\sigma}] - \sigma\}\tau \right\}$$
$$= 1 - \alpha + (1-\alpha-\sigma)\infty < 0,$$

since $1-\alpha-\sigma < 0$ in this case. However, if $0 < \sigma < 1$, the above calculation is not valid. Then (2.26) gives

$$\tau < \lambda_M^{\sigma/(\sigma-1)} - 1 \equiv \tilde{\tau}.$$

$$\lim_{\tau \to \tilde{\tau}} \psi(\tau) = -\sigma(\lambda_M^{\sigma/(\sigma-1)} - 1) < 0.$$

Next, let us consider the uniqueness. Noting that $\psi(\tau)$ is continuous in τ and that $\psi(0) > 0$, the solution to (2.27) nearest to zero satisfies

$$\psi'(\tau) \leq 0. \tag{2A.2}$$

Then if there were multiple solutions, there must exist $\tilde{\tilde{\tau}} \in (0, \tilde{\tau})$ such that it satisfy

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(2.27) and

$$\psi'(\tilde{\tilde{\tau}}) \geq 0.$$

it is proved that any solution to (2.27) must satisfy (2A.2) with strict inequality, so that $\tilde{\tilde{\tau}}$ can not exist.

The first derivative of $\psi(\tau)$ is calculated as

$$\psi'(\tau) = (1-\alpha)[1-\lambda_M^\sigma (1+\tau)^{1-\sigma}] - (1-\alpha)(1-\sigma)\lambda_M^\sigma (1+\tau)^{1-\sigma} - \sigma. \qquad (2A.3)$$

If $\sigma \geq 1-\alpha$, further calculation of (2A.3) gives

$$\psi'(\tau) = (1-\alpha-\sigma)[1-\lambda_M^\sigma (1+\tau)^{1-\sigma}] - [1-\alpha(1-\sigma)]\lambda_M^\sigma (1+\tau)^{1-\sigma} < 0,$$

since $1-\alpha(1-\sigma) \geq 1-\alpha^2 > 0$. Note that this holds globally. But what if $\sigma < 1-\alpha$? Rewriting (2.27), we have

$$(1-\alpha)[1-\lambda_M^\sigma (1+\tau)^{1-\sigma}] = \sigma\tau/(1+\tau). \qquad (2A.4)$$

Substituting this into (2A.3), we get

$$\psi'(\tau) = \sigma[-1/(1+\tau)] - (1-\alpha)(1-\sigma)\lambda_M^\sigma (1+\tau)^{1-\sigma} < 0,$$

since $1-\sigma > \alpha > 0$. In any case, any solution to (2.27) satisfies (2A.2) with strict inequality.   Q.E.D.

Appendix 2B   Proof of Proposition 2.4

When $\sigma \neq 1$, $\gamma^2(\hat{\tau}^2) < \gamma^3(s^{3*})$ is equivalent to

$$[1 - \lambda_M^\sigma (1+\hat{\tau}^2)^{1-\sigma}]^{1/(1-\sigma)}\{\alpha + \hat{\tau}^2 \lambda_M^\sigma (1+\hat{\tau}^2)^{-\sigma}[1 - \lambda_M^\sigma (1+\hat{\tau}^2)^{1-\sigma}]^{-1}\} < (1 - \lambda_M^\sigma)^{1/(1-\sigma)}.$$

Rewriting (2.27) gives

$$\hat{\tau}^2 \lambda_M^\sigma (1+\hat{\tau}^2)^{-\sigma}[1 - \lambda_M^\sigma (1+\hat{\tau}^2)^{1-\sigma}]^{-1} = (1-\alpha)(\lambda_M^\sigma / \sigma)(1+\hat{\tau}^2)^{1-\sigma}.$$

Substituting this into the left-hand side of the above inequality, and rearranging terms, we get

$$[1 - \lambda_M^\sigma (1+\hat{\tau}^2)^{1-\sigma}]^{1/(1-\sigma)}\{\alpha + \hat{\tau}^2 \lambda_M^\sigma (1+\hat{\tau}^2)^{-\sigma}[1 - \lambda_M^\sigma (1+\hat{\tau}^2)^{1-\sigma}]^{-1}\}$$
$$= [1 - \lambda_M^\sigma (1+\hat{\tau}^2)^{1-\sigma}]^{1/(1-\sigma)}[\alpha + (1-\alpha)(\lambda_M^\sigma / \sigma)(1+\hat{\tau}^2)^{1-\sigma}]$$
$$< (1 - \lambda_M^\sigma)^{1/(1-\sigma)} \quad \Leftarrow \quad \sigma > 1.$$

When $\sigma = 1$, $\gamma^2(\hat{\tau}^2) < \gamma^3(s^{3*})$ is equivalent to

$$(1+\hat{\tau}^2)^{\lambda_M / (\lambda_M - 1)}[\alpha + \hat{\tau}^2 \lambda_M (1+\hat{\tau}^2)^{-1}(1-\lambda_M)^{-1}] < 1.$$

Using (2.27), the left-hand side becomes

$$(1+\hat{\tau}^2)^{\lambda_M / (\lambda_M - 1)}[\alpha + \hat{\tau}^2 \lambda_M (1+\hat{\tau}^2)^{-1}(1-\lambda_M)^{-1}]$$
$$= (1+\hat{\tau}^2)^{\lambda_M / (\lambda_M - 1)}[\alpha + (1-\alpha)\lambda_M] < 1.$$

Q.E.D.

Fig. 2.1.

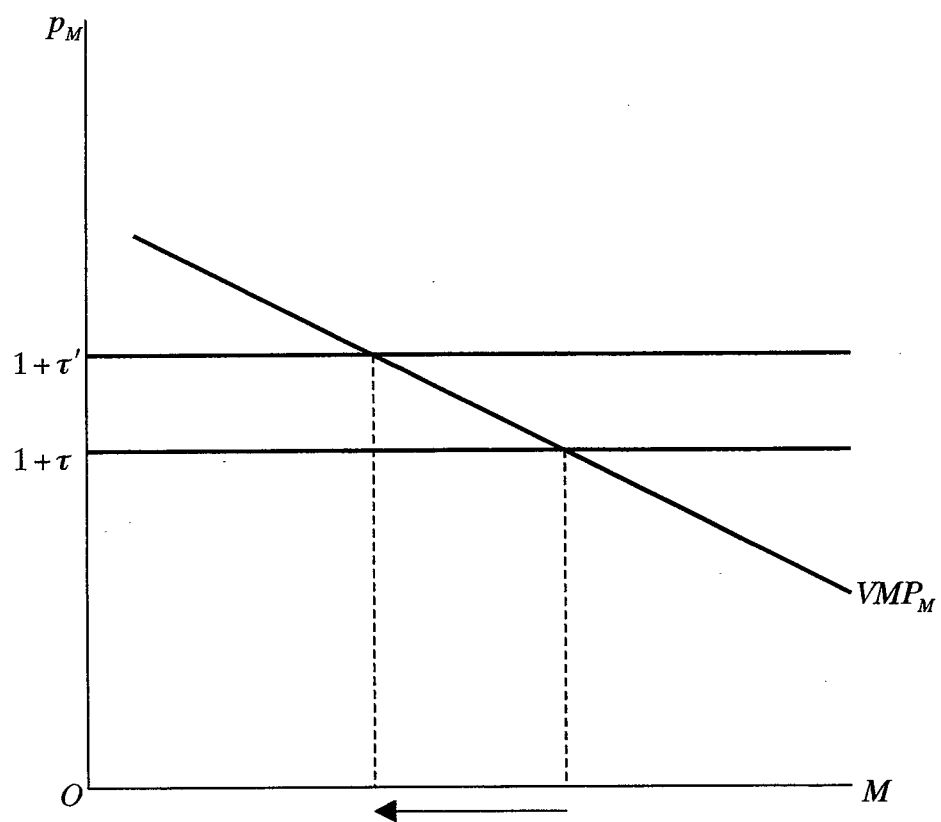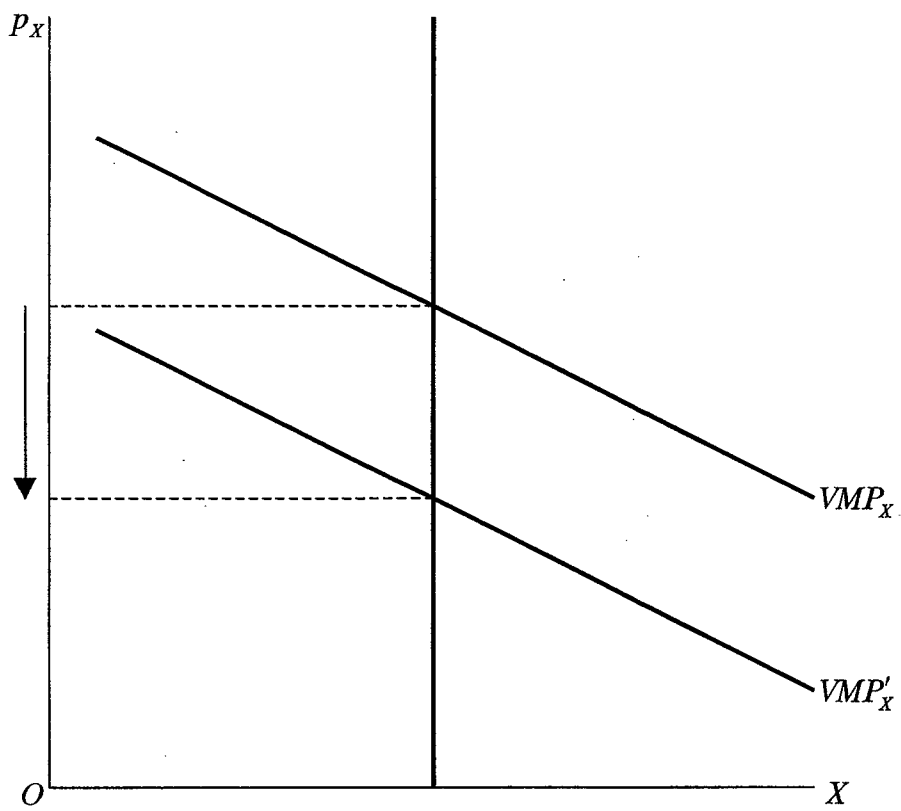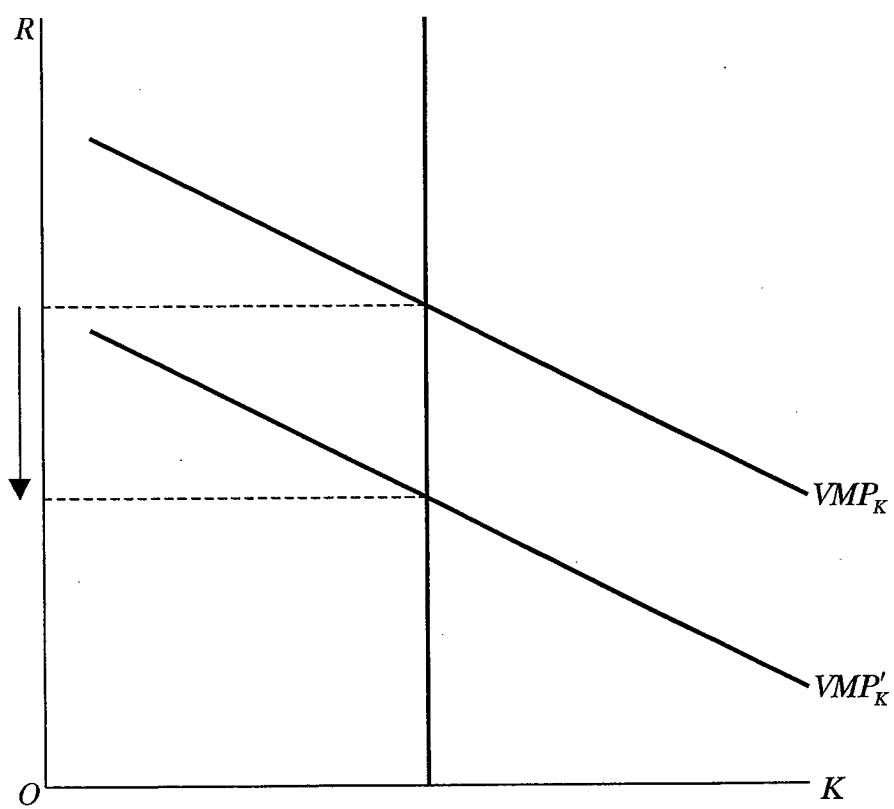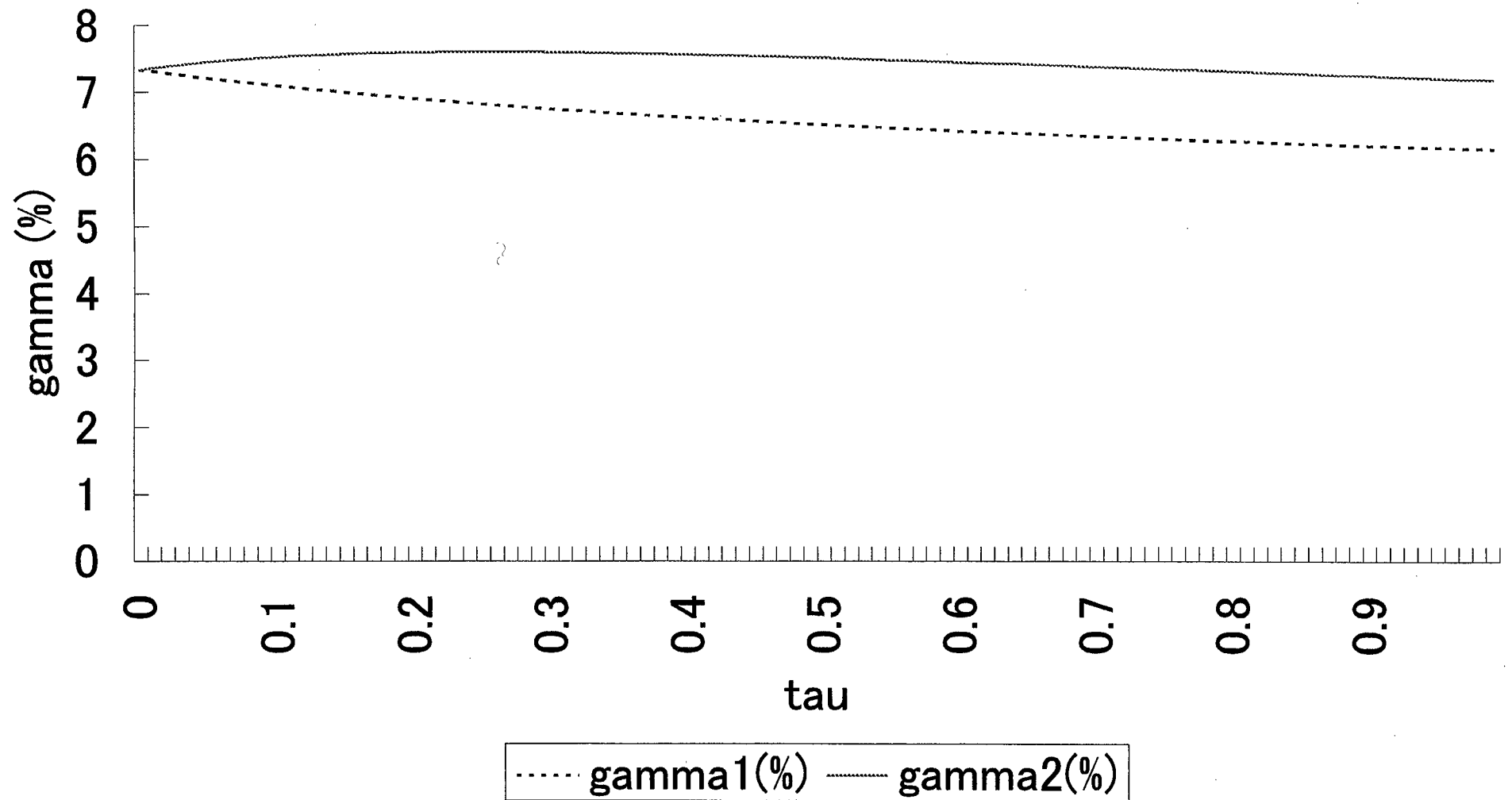Fig. 2.2.

Fig. 2.3.

Fig. 2.4a. growth (sigma=2)

gamma (%)

tau

----- gamma1(%) ——— gamma2(%)

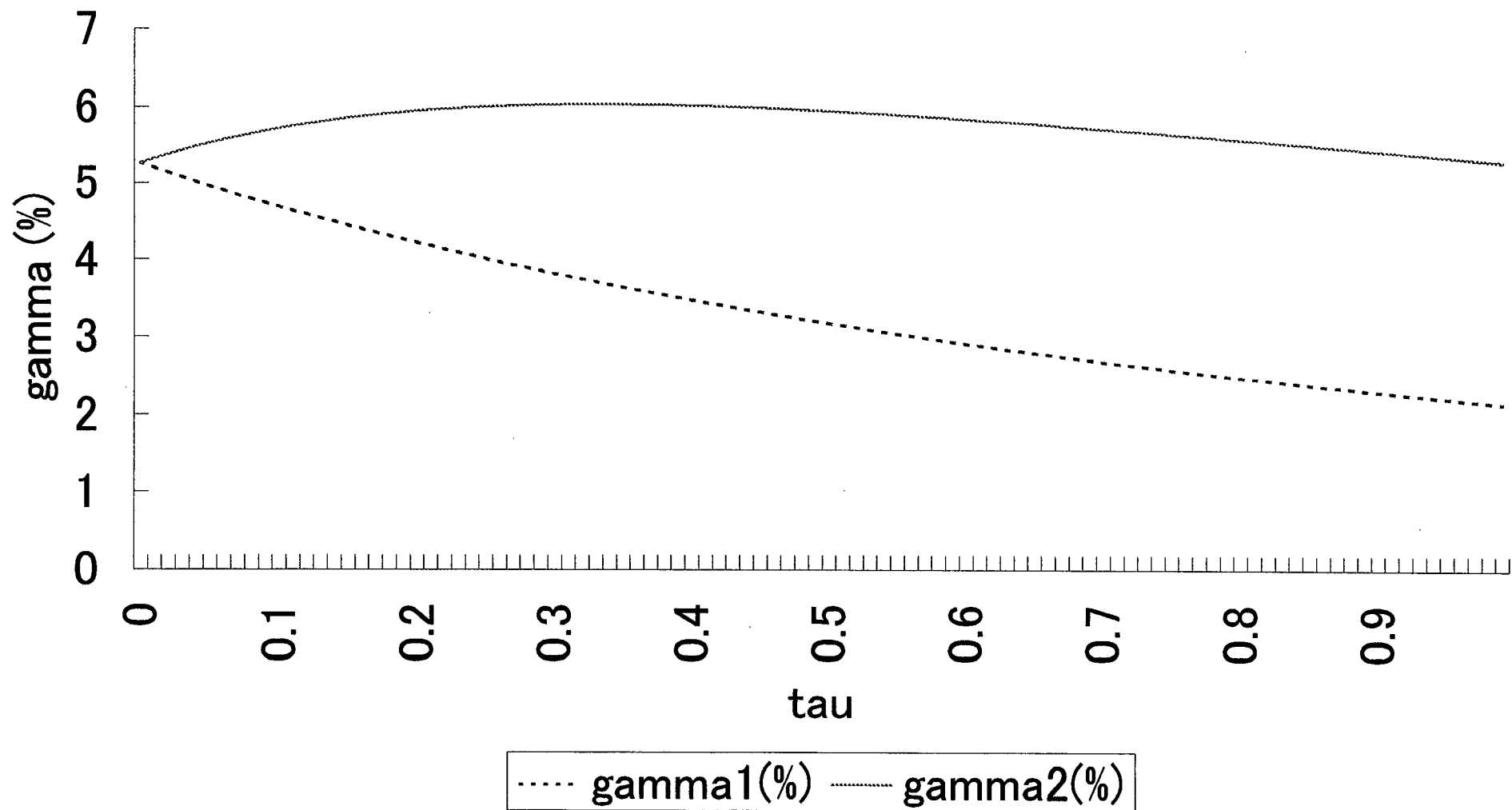Fig. 2.4b. welfare （sigma=2）

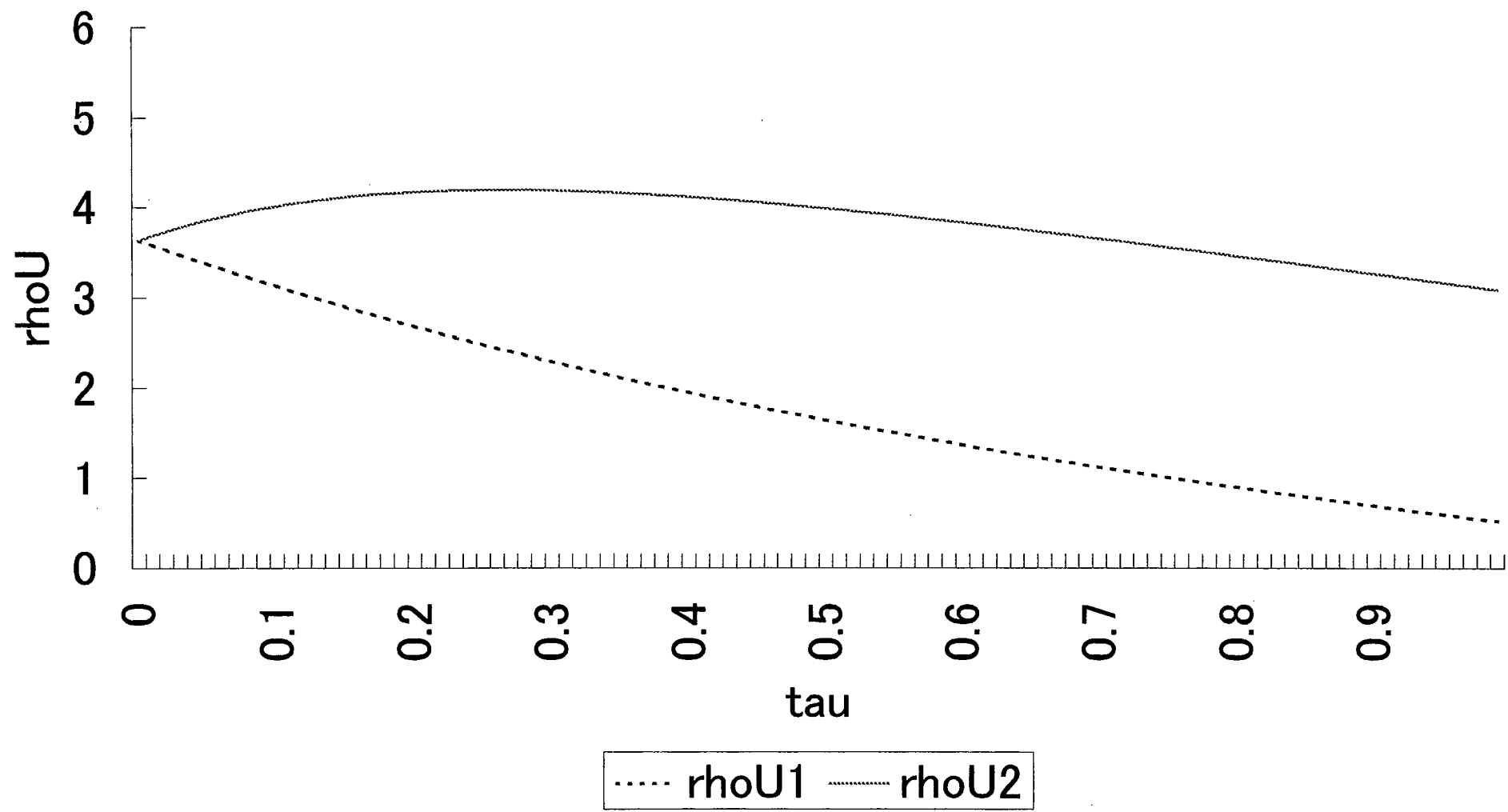Fig. 2.5a.　growth　（sigma=1）

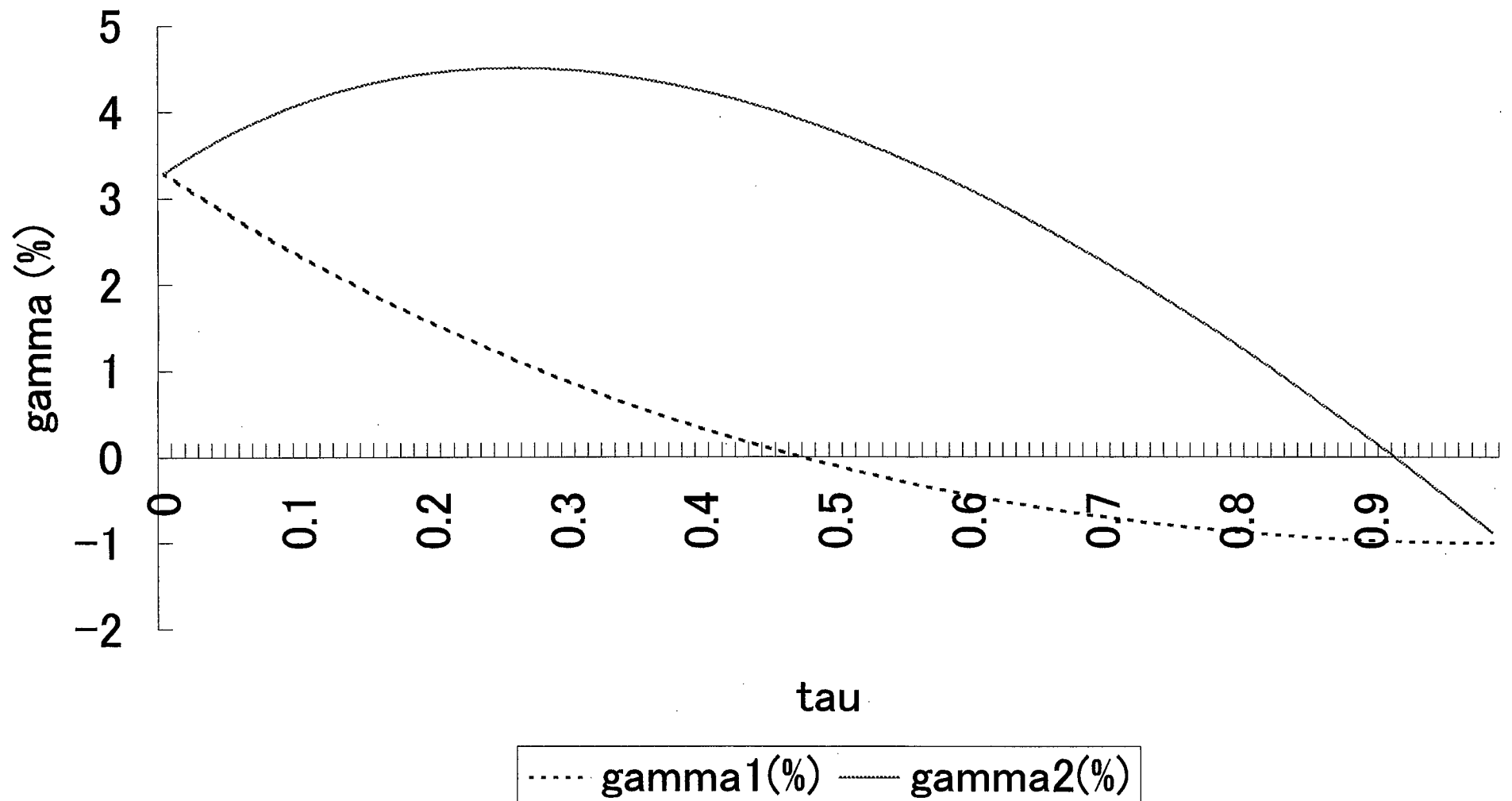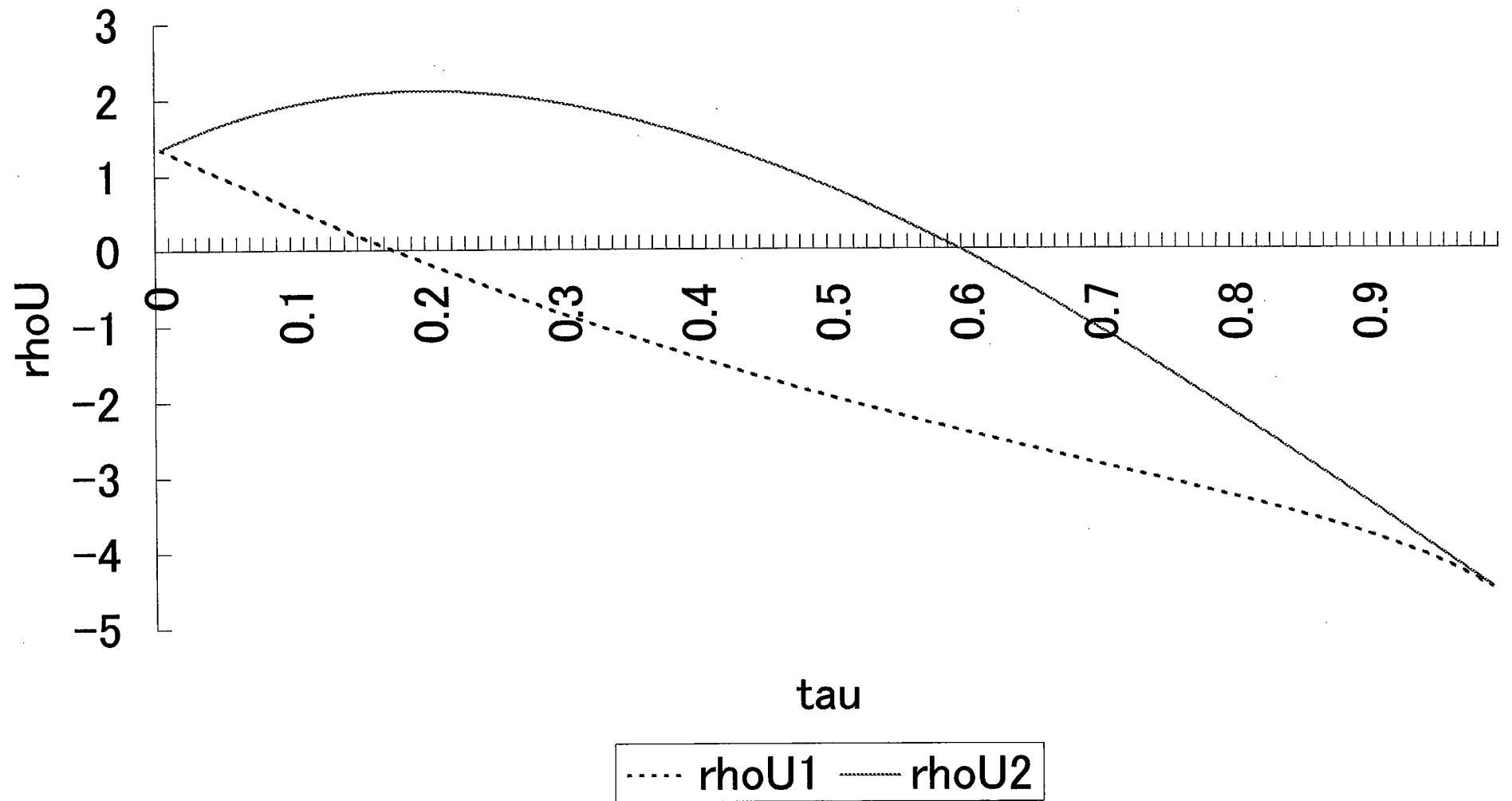gamma1(%)　　gamma2(%)

Fig. 2.5b.　welfare　（sigma=1）

Fig. 2.6a.　growth　（sigma=0.5）
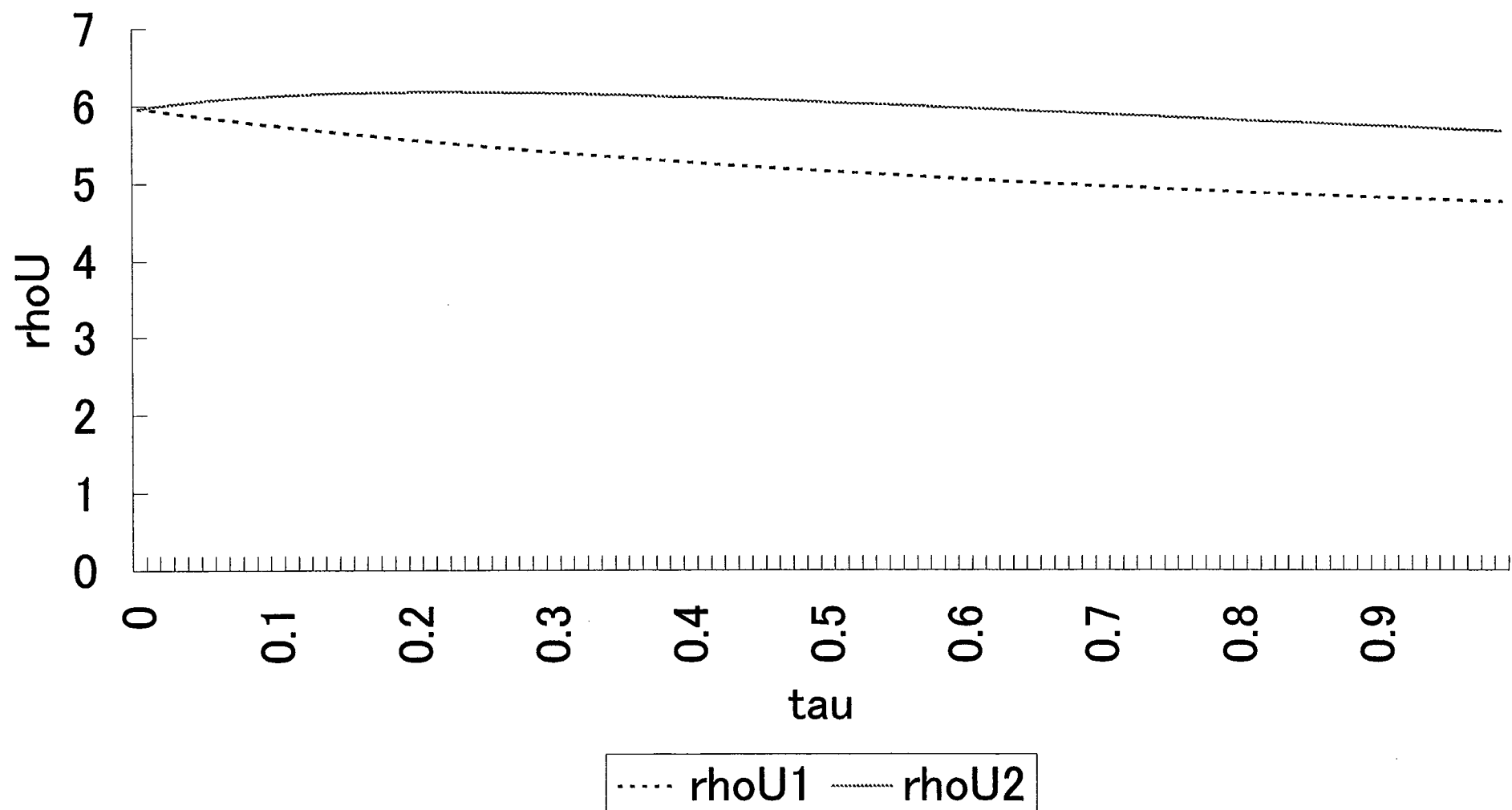
Fig. 2.6b. welfare (sigma=0.5)

3 A rationale for infant industry protection and gradual trade liberalization

3.1 Introduction

The East Asian economies have been praised for their remarkable growth performance since 1980's, although they struggle for the recessions beginning in 1997. Some developing economists attribute their success to their outward-oriented trade policies. In fact, all the governments in this area have been liberalizing foreign transactions step by step. However, it is important to note that all the East Asian economies except Hong Kong had implemented some forms of trade protection before the gradual trade liberalization took place.[1] Why did they protect some sectors initially? Why do they reduce the degree of protection gradually, rather than suddenly or not at all? The purpose of this paper is to give a theoretical framework so as to answer these questions.

This paper will show that the optimal path of trade policy is an element of gradual trade liberalization in the context of the infant industry argument.[2] Since protection of the infant industry is carried out temporarily and selectively, it is suitable to build a dynamic general equilibrium model. Bardhan (1971) constructs a two-final-good, two-factor, small-open model in which cumulated output of a sector contributes to productivity of only the sector itself in a non-appropriable way. He shows that the optimal rate of protection decreases gradually and takes a positive value in the steady state.[3] Fung and Ishikawa (1992) present a two-final-good, two-factor, small-open endogenous growth model which incorporates variety expansion due to R&D in intermediate good sector. They show that imposing a production tax on the traditional sector for some time and removing it immediately make the otherwise zero-growth economy take off. The main contribution in this paper is to find out that a particular path of gradual trade liberalization followed by free trade is optimal.

We construct a small-open endogenous growth model based on R&D. There are two final goods, each of which is produced from labor and a variety of intermediate

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[1] World Bank (1993) provides historical and institutional perspectives on the East Asian growth.

[2] Corden (1974) gives a classic review of the infant industry argument.

[3] Succar (1987) generalizes Bardhan (1971) by assuming that cumulative output of a sector raises productivity of both sectors, and obtains similar relults.

goods. In intermediate good sector, each variety is made out of labor alone. R&D means that a potential firm pays a fixed cost to create a new variety and enter the intermediate good sector. The framework resembles the two-final-good, two-primary-factor, small-open models of Fung and Ishikawa (1992) and Grossman and Helpman (1991, Chap. 6), and the one-final-good, one-primary-factor, closed-economy model of Ciccone and Matsuyama (1996, Sec. 7).

Let us see how the model works. The small open economy completely specializes in only one of the two final goods, labor-intensive one (called good 1) and intermediate-good-intensive one (good 2). This is because constant returns to scale prevails in each sector in each period, and the number of final goods is larger than that of primary factors. The larger is the number of varieties of intermediate goods available in the period, the lower relative cost of good 2 to good 1, and the more likely the economy specializes in the former, given domestic prices. This is easily understood by thinking that relative price of intermediate goods as a whole to labor goes down as the number of varieties increases. As for dynamics, the growth rate in the steady state with specialization in good 2 is always higher than that with specialization in good 1, because of profit and resource effects: good-2 firms pay more to intermediate goods than good-1 firms, and then the profit rate is higher; good-2 firms use less labor directly than good-1 firms, and so the total labor coefficient is smaller, which makes more room for R&D. If parameters are such that the former growth rate is positive and the latter is zero, and if the initial number of varieties is so small that the economy specializes in good 1 in free trade, the economy falls into the poverty trap, that is, it can not grow forever although it can if it specializes in good 2. In this model, history (i.e., initial number of varieties) together with an external environment (i.e., world prices) determines one equilibrium out of the two.[4]

Because of the Ricardian feature with only two steady states, it is very easy to analyze the effect of trade policy in the trapped economy specializing in good 1 in free trade. Initially, distort the price of good 2 upward so that the economy specialize in the good. Then the number of varieties starts to grow, with the relative cost of good 2 declining faster than the world relative price of good 2. This enables the government to reduce the degree of protection gradually and remove it finally. Moreover, considering the welfare of the representative household, less protection is better. Therefore, the optimal trade policy is gradual trade liberalization with the rate of protection kept to a minimum for specialization in good 2.

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[4] In the literature on multiple equilibria, either history or expectation determines the equilibrium. See Krugman (1991).

The rest of this paper is organized as follows. Section 3.2 formulates the basic model. Section 3.3 analyzes the small open economy, and shows that under some conditions there exists the poverty trap characterized by zero growth in free trade. Section 3.4 discusses trade policy for escaping from the poverty trap. Section 3.5 concludes.

3.2 The model

Consider a small open economy with two tradable final good sectors and one non-tradable intermediate good sector.[5] It is assumed that all economic agents have perfect foresight. In the final good sector j ($j = 1,2$), firms are subject to the following production function.

$$Y_j(t) = F_j(X_j(t), L_j(t)) = B_j X_j(t)^{\alpha_j} L_j(t)^{1-\alpha_j} ; \alpha_j \in (0,1),$$

$$X_j(t) = G(\{x_j(i,t)\}_{i=0}^{n(t)}) = (\int_0^{n(t)} x_j(i,t)^{(\sigma-1)/\sigma} di)^{\sigma/(\sigma-1)} ; \sigma > 1,$$

where Y_j, X_j, L_j, α_j, $x_j(i)$, n, and σ denote output, index of intermediate goods employed, labor employed, factor share of X_j, variety $i \in [0,n]$ of intermediate good employed, measure of the number of varieties of intermediate goods (assumed to be continuous), and elasticity of substitution between any two varieties, respectively.[6] Suppose that $\alpha_1 < \alpha_2$, that is, firms in sector 2 pay more to intermediate goods than those in sector 1, implying that good 2 is intermediate-good-intensive while good 1 is labor-intensive. Cost minimization subject to the specified technology given input prices implies that

$$P_X(\{p_x(i,t)\}_{i=0}^{n(t)}) = (\int_0^{n(t)} p_x(i,t)^{1-\sigma} di)^{1/(1-\sigma)}, \tag{3.1}$$

$$c_j(P_X(t), w(t)) = P_X(t)^{\alpha_j} w(t)^{1-\alpha_j}, \tag{3.2}$$

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[5] Non-tradability of the intermediate goods is assumed in order to focus on one route from which trade affects growth. Fung and Ishikawa (1992) and Grossman and Helpman (1991, Chap. 6), among others, follow this assumption. Rodrik (1996) gives some interpretations of it.

[6] Once stated, time variable t is omitted unless it causes some confusion.

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where P_X, $p_x(i)$, c_j, and w denote price index associated with X_j, price of variety i, unit cost in producing Y_j, and wage, respectively. Let $p_j(t)$ denote domestic price of good j. Because of perfect competition, good j is produced according to the following condition.

$$p_j \leq c_j(P_X, w), Y_j \geq 0, Y_j(p_j - c_j(P_X, w)) = 0. \tag{3.3}$$

After getting a patent for its own invention, each firm exclusively producing variety i of intermediate good maximizes its profit,[7] given the action of the other firms of differentiated varieties, the quantity of final goods produced, and wage. Calculating the derived demand from (3.1) and (3.2), and noting that each firm is in almost zero measure in the intermediate good sector, the own price elasticity of demand equals σ. Then the first-order condition of profit maximization is given by $p_x(i)(1 - 1/\sigma) = wa_x$, where a_x denotes unit labor requirement in producing $x(i)$, which is assumed to be common to any firm i. For simplicity, let us choose the unit of measurement so that $a_x = 1 - 1/\sigma$. Then the above pricing formula becomes

$$p_x(i) = w. \tag{3.4}$$

From (3.4) and the form of $X_j = G(\cdot)$, $p_x(i)$ and $x(i)$ are the same among varieties, so i is omitted unless some confusion arises. Then from (3.1) and (3.4), we have

$$P_X = wn^{1/(1-\sigma)}. \tag{3.5}$$

This implies that the larger n is, the lower P_X is for given w. In other words, an increase in the number of varieties makes intermediate goods as a whole relatively cheaper than labor. The representative firm's gross profit $\pi(t)$ is defined as $\pi(t) \equiv p_x(t)x(t) - w(t)a_x x(t) = p_x(t)x(t)/\sigma$, and its firm value $v(t)$ is expressed as $v(t) \equiv \int_t^\infty \exp(-\int_t^\tau r(s)ds)\pi(\tau)d\tau$, where r denotes interest rate on loans.

Potential firms can participate in the intermediate good sector after investing in creating a new variety. The fixed cost measured in terms of labor takes the form $a_n/n(t)$,

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[7] Here maximization of profit in each period is equivalent to maximization of firm value, since the firm does not have any state variable which is subject to adjustment cost.

where a_n is a positive constant. The fixed cost decreases with $n(t)$, which represents the aggregate stock of knowledge in period t. However, the predecessors' contribution to the technological improvement is not compensated. Comparing benefit of entry with cost, the potential entrants decide whether to enter. The free entry condition is given by

$$v(t) \le w(t)a_n / n(t), \dot{n}(t) \ge 0, \dot{n}(t)(v(t) - w(t)a_n / n(t)) = 0, \qquad (3.6)$$

where a dot over a variable represents differentiation with respect to t.

The representative household maximizes the discounted sum of log utility $U = \int_0^\infty e^{-\rho t} \ln C(t) dt$, where ρ denotes subjective discount rate, and the index of instantaneous consumption $C(t) = u(C_1(t), C_2(t))$ is assumed to be increasing, concave, and differentiable. The dynamic budget constraint is

$$\dot{A}(t) = r(t)A(t) + w(t)L + T(t) - E(t); E(t) \equiv p_1(t)C_1(t) + p_2(t)C_2(t), \qquad (3.7)$$

where A, L, T, and E denote asset, endowment of labor, lump-sum transfer, and value of expenditure, respectively. Dynamic optimization yields the transversality condition and the following Euler equation:

$$\gamma_E(t) = r(t) - \rho, \qquad (3.8)$$

where $\gamma_\cdot$ denotes growth rate of the subscript.

Let us consider the equilibrium conditions. The intermediate good market $i \in [0, n]$ clear if $x(i) = x_1(i) + x_2(i)$, and the labor market clearing condition is

$$L = L_1 + L_2 + na_x(x_1 + x_2) + (a_n / n)\dot{n}. \qquad (3.9)$$

In the asset market, two perfectly substitutable assets, the claim of loans and the share of stocks, are traded only domestically. Differentiating the defining equation of v, the no-arbitrage condition is expressed as

$$r = (\pi + \dot{v}) / v. \qquad (3.10)$$

With the asset market clearing condition $A = nv$, we complete the description of the model.

To derive the key dynamic equations, let $z \equiv E / (nv)$ denote ratio of expenditure

to aggregate firm value. Because of the asset market clearing condition, it can be interpreted as marginal and average propensity to expend out of asset. Noting that $\alpha_j = np_x x_j /(p_j Y_j)$ and $1 - \alpha_j = wL_j /(p_j Y_j)$, the resource constraint (3.9) is combined with (3.4) and (3.6) to yield

$$\gamma_n = \max\{L/a_n - [(1 - \alpha_1/\sigma)p_1 Y_1 /E + (1 - \alpha_2/\sigma)p_2 Y_2 /E]z, 0\}. \qquad (3.11)$$

Using the expression for π, the intermediate good market clearing condition, and (3.10), the Euler equation (3.8) is transformed into

$$\gamma_z = (1/\sigma)(\alpha_1 p_1 Y_1 /E + \alpha_2 p_2 Y_2 /E)z - \gamma_n - \rho. \qquad (3.12)$$

3.3   Small open economy

We are concerned with a small open economy, which takes the time path of terms of trade as given. Originating in Grossman and Helpman (1991), there has been a lot of literature on open endogenous growth models, of which multi-economy models account for a larger part than small-economy ones.[8] The small-open assumption is adopted for both practical and theoretical reasons: we are interested in growth in a developing economy which can be regarded as small relative to the world; the pure growth-enhancing effect of protection must be examined separately from the beggar-thy-neighbor terms-of-trade effect and the resulting strategic aspect.

Let $p_j^f(t)$ denote world price of good j. Noting that Walras' law holds in the economy,[9] let good 2 be the numeraire: $p_2^f(t) = 1 \forall t$. The small-open assumption means that $\{p_1^f(t)\}_{t=0}^{\infty}$ is exogenous, but may not necessarily be constant. Suppose that the government imposes (or gives) an ad-valorem import tariff (or export subsidy) of the rate $\delta_j(t)$ on (or to) good j, and redistributes the tariff revenue to (or taxes for financing the subsidy on) households in a lump-sum manner. Then the domestic price of good j is

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[8] The multi-economy models deal with the North-South problem, that is, they try to answer whether growth rates of North and South converge or not as a result of trade in final goods, intermediate goods, and/or knowledge. Feenstra (1996) gives a synthesis. Making use of an R&D-based model, he claims that whether knowledge diffuses across borders is essential for convergence.

[9] From (3.4), $\pi = p_x x /\sigma$, (3.6), (3.7), $x = x_1 + x_2$, (3.9), (3.10), and $A = nv$, we get the static budget constraint: $p_1(C_1 - Y_1) + p_2(C_2 - Y_2) = T$.

given by $p_j(t) = (1 + \delta_j(t))p_j^f(t)$, and the government's budget constraint is expressed as $T = \delta_1 p_1^f(C_1 - Y_1) + \delta_2(C_2 - Y_2)$.

Let us consider how patterns of specialization are determined. From (3.2) and (3.5), relative cost of good 1 to good 2 is defined as

$$c \equiv c_1(P_X, w) / c_2(P_X, w)$$
$$= n^{(\alpha_2 - \alpha_1)/(\sigma - 1)} \equiv c(n); c'(n) > 0.$$

The larger n is, the lower the relative price of intermediate goods as a whole to labor, and then the higher the cost of the labor-intensive final good relative to the intermediate-good-intensive one. It is important to note that the relative cost depends on n alone, not the allocation of final goods. This says that the production possibility frontier is linear. Let $\hat{n}$ denote threshold level of n at which both final goods are produced given p_1 and p_2. It is implicitly defined as

$$p_1 / p_2 = c(\hat{n}). \tag{3.13}$$

The economy specializes in good 1 (or 2) if and only if[10]

$$n(t) < (or >)\hat{n}(t).$$

In Fig. 3.1, ray $On(t)$ represents (3.5) for a particular value of $n(t)$. The slope of $c_2(P_X, w) = p_2(t)$ seen from the horizontal axis must be steeper than that of $c_1(P_X, w) = p_1(t)$ for any common relative input price P_X / w, since those slopes represent relative input intensities X_2 / L_2 and X_1 / L_1, respectively, and good 2 is intermediate-good-intensive. In free trade, $\hat{n}^f(t)$ is determined so that ray $O\hat{n}^f(t)$ cross the intersection of $c_1(\cdot) = p_1^f(t)$ and $c_2(\cdot) = 1$.[11] In the illustrated case, $n(t) < \hat{n}^f(t)$, and then the economy specializes in good 1, since firms in the sector offer higher input prices than those in the other sector. The equilibrium values of $P_X(t)$ and $w(t)$ are given at point A.

The next thing to consider is the dynamics. If the economy specializes in good j, (3.11) and (3.12) reduce to

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[10] If $n(t) = \hat{n}(t)$, the economy is diversified, but the exact production allocation is indeterminate. Since this happens by tiny chance, the case is not pursued.

[11] From (3.13), $\hat{n}^f(t)$ is implicitly determined as $p_1^f(t) = c(\hat{n}^f(t))$.

$$\gamma_n = \max\{L/a_n - (1 - \alpha_j/\sigma)(p_j Y_j/E)z, 0\}, \tag{3.14}$$

$$\gamma_z = (\alpha_j/\sigma)(p_j Y_j/E)z - \gamma_n - \rho. \tag{3.15}$$

Fig. 3.2 shows how the equilibrium dynamics is determined. Schedule $NN_j N$ represents (3.14), while $\dot{z} = 0$ locus corresponding to (3.15) is given by schedule $Z_j Z$. Assuming at the moment that $\gamma_n > 0$, the equilibrium values of z and γ_n are solved from (3.14) and (3.15) as[12]

$$z = [E/(p_j Y_j)](L/a_n + \rho) \equiv z_j,$$

$$\gamma_n = (1/\sigma)[\alpha_j L/a_n - (\sigma - \alpha_j)\rho] \equiv \gamma_{nj}.$$

The two schedules intersect at S_j in the positive orthant (i.e. $\gamma_n > 0$) if and only if

$$L/a_n > \rho(\sigma - \alpha_j)/\alpha_j.$$

For R&D to occur, the effective labor endowment measured in terms of productivity in R&D L/a_n must be so large that it should not be used up by the other activities.[13] In equilibrium, the economy jumps to the steady state S_j in the initial period, and stays there with positive constant growth rate of n.[14]

On the other hand, if and only if $L/a_n \leq \rho(\sigma - \alpha_j)/\alpha_j$, the steady state S_j is given at the intersection of schedule $Z_j Z$ and the vertical part of schedule $NN_j N$, where $z = [E/(p_j Y_j)]\rho\sigma/\alpha_j \geq z^j$.

We now concentrate on the case of the poverty trap: history together with an external environment forces the economy to endure zero growth, *despite that it has a potential to grow.* The poverty trap is characterized by the following three conditions.

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[12] $z_j = L/a_n + \rho \equiv z_j^f$ in free trade, while $z_j > (or <)z_j^f$ if and only if there exists an import tariff (or an export subsidy). This is verified from the government's budget constraint and the household's static budget constraint.

[13] From (3.14) and (3.15), we have $\gamma_n = L/a_n - (1 - \alpha_j/\sigma)(L/a_n + \rho)$. The second term in the right-hand side represents the total labor demand from the good- j and the intermediate good firms.

[14] This can be proved in the same way as Grossman and Helpman (1991, pp. 60-61).

$$\rho(\sigma - \alpha_2)/\alpha_2 < L/a_n \leq \rho(\sigma - \alpha_1)/\alpha_1,$$

$$n(0) < \hat{n}^f(0),$$

$$0 \leq \gamma_{p_1^f} < [(\alpha_2 - \alpha_1)/(\sigma - 1)]\gamma_{n2}.$$

The first condition implies that the economy can grow at the rate $\gamma_{n2} > 0$ if it specializes in good 2, but it can not grow if it specializes in good 1. The second says that the economy specializes in good 1 in free trade in the initial period. The third means that either the world relative price of good 2 is constant or it falls more slowly than the relative cost of the small open economy if it specializes in good 2. The world relative price of the intermediate-good-intensive to the labor-intensive final good may fall at a constant rate in the steady state if each economy in the rest of the world also conduct R&D. Under these assumptions, the economy specializes in good 1 and does not grow forever in free trade. However, if the economy continues to specialize in good 2 and to grow until the relative cost of good 2 becomes lower than the world relative price, after that the economy will be able to grow by itself. Unfortunately, the economy can not escape from the poverty trap only by private incentives.

3.4 Trade policy

How can the government induce the trapped economy to grow by using trade policy? In Fig. 3.1, suppose that the government raises the price of good 2 so that $n(t) > \hat{n}^d(t)$, where $\hat{n}^d(t)$ is the threshold with distortion in period t.[15] Raising both sides to the $(\alpha_2 - \alpha_1)/(\sigma - 1)$[th] power, and noting (3.13), we get

$$n(t)^{(\alpha_2 - \alpha_1)/(\sigma - 1)} > p_1^f(t)/(1 + \delta_2(t)).$$

The value of $\delta_2(t)$ which satisfies the above inequality is expressed as

$$1 + \delta_2(t) = p_1^f(t)[n(t)(1 - \varepsilon(t))]^{(\alpha_1 - \alpha_2)/(\sigma - 1)}; \varepsilon(t) \in (0,1). \tag{3.16}$$

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[15] Now the equilibrium values of $P_X(t)$ and $w(t)$ are given at point B.

Under such $\delta_2(t)$, the economy specializes in good 2, with n growing at γ_{n2}. Note that $\delta_2(t)$ now becomes an export subsidy.[16]

Remarkably, the protection need not be permanent. Since the economy specializes in good 2, $n(t)$ grows faster than $\hat{n}^f(t)$.[17] Once $n(t)$ exceeds $\hat{n}^f(t)$, the economy can grow without aid. Moreover, it is possible to reduce the degree of protection gradually. All the government has to do is to control $\delta_2(t)$ so that $\hat{n}^d(t)$ be smaller than $n(t)$ all the time. Since $n(t)$ grows, $\hat{n}^d(t)$ can be raised by reducing $\delta_2(t)$. Note that z rises during that period, since the tax burden to finance the subsidy decreases. See Fig. 3.2. If $\delta_2(t) > 0$, schedule $NN_2^d N$ (representing (3.14)) and schedule $Z_2^d Z$ (representing (3.15)) intersect at S_2^d, which is vertically below S_2^f, the steady state in free trade with specialization in good 2. As $\delta_2(t)$ goes down, S_2^d approaches toward S_2^f.[18] To sum up,

Proposition 3.1.   The trapped economy can grow with n growing at the constant rate γ_{n2} by giving an export subsidy to good 2 according to (3.16). The protection can be temporary and the degree of it can be reduced gradually. During the period of gradual trade liberalization, z rises and approaches to $z_2^f = L / a_n + \rho$.

From the normative point of view, the effect of the entire path of protection on welfare must be evaluated. For example, consider the following *minimum-protection policy*. Reduce $\delta_2(t)$ so that $\hat{n}^d(t)$ be infinitesimally smaller than $n(t)$ in any period, and remove the protection once $n(t)$ exceeds $\hat{n}^f(t)$. Formally, the path of the minimum-protection policy $\{\delta_2^*(t)\}$ is described as

$$1 + \delta_2^*(t) = p_1^f(0)\exp(\gamma_{p_1^f}t)[n(0)\exp(\gamma_{n2}t)(1-\varepsilon)]^{(\alpha_1-\alpha_2)/(\sigma-1)}, \qquad (3.17)$$

---

[16] Taking account of quantitative measures in the present model, an import quota on good 2 is not sufficient for takeoff. The government must even impose a minimum export requirement on good 2 and compensate the exporters of good 2 for the difference between domestic and the world prices. If we choose the path of the minimum export requirement so that it should give the path of implicit subsidy rate being the same as $\{\delta_2(t)\}$, this policy is equivalent to the export subsidy considered in the text.

[17] Inverting (3.13), we have $\hat{n}^f(t) = p_1^f(t)^{(\sigma-1)/(\alpha_2-\alpha_1)}$. Together with the assumption of $\gamma_{p_1^f}$, this implies that $\gamma_{\hat{n}^f} = [(\sigma-1)/(\alpha_2-\alpha_1)]\gamma_{p_1^f} < \gamma_{n2}$.

[18] The economy must be always at the intersection of the two schedules, since all households and firms foresee the path of protection and act according to it in any period.

where ε is an infinitesimal positive constant. The period of complete liberalization under the minimum-protection policy is identified by letting $\delta_2^*(t) = 0$ in (3.17) and solving it for t. It is

$$t = (1/\Delta)\{\ln p_1^f(0) - [(\alpha_2 - \alpha_1)/(\sigma - 1)]\ln n(0) - [(\alpha_2 - \alpha_1)/(\sigma - 1)]\ln(1 - \varepsilon)\} \equiv t^*; (3.18)$$

$$\Delta \equiv [(\alpha_2 - \alpha_1)/(\sigma - 1)]\gamma_{n2} - \gamma_{p_1^f} > 0.$$

At t^* and thereafter, $\delta_2^*(t) = 0$. The following proposition claims that the minimum-protection policy is actually optimal.[19]

Proposition 3.2. *The minimum-protection policy characterized by (3.17) and (3.18) is the optimal trade policy for growth in the trapped economy.*

Proof. This is proved with the help of Fig. 3.3. First, if we take $\delta_2^*(t)$, the production point is given at point $Y_2(t)$, and the consumption point $C^*(t)$ is at the intersection of the world price line and the budget line associated with $\delta_2^*(t)$. Next, take $\delta_2^{**}(t)(> \delta_2^*(t))$ arbitrarily. This does not alter the production allocation. However, the marginal rate of substitution of good 1 to good 2 at point $C^*(t)$ is larger than the relative price, so the consumption point moves on the world price line to the southeast, say point $C^{**}(t)$. Since point $C^{**}(t)$ lies strictly inside the budget set associated with $\delta_2^*(t)$, $C^*(t)$ is strictly directly revealed preferred to $C^{**}(t)$. Q.E.D.

3.5 Concluding remarks

This paper provides one theoretical explanation for infant industry protection and gradual trade liberalization. For the infant industry argument to make sense, the effective labor endowment measured in terms of productivity in R&D must be within an appropriate range, the initial number of varieties of intermediate goods must be

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[19] Taking the minimum-protection policy might be worse than doing nothing. Extremely high and fast-growing p_1^f discourages the government from carrying it out by increasing the benefit of free trade and the cost of the protection: terms of trade in exporting good 1 is very favorable; the volume of the protection is very large and its duration is very long. Let us assume that this is not the case.

sufficiently small, and the world relative price of the intermediate-good-intensive to the labor-intensive final good must not fall so fast. In this case, temporary protection of the intermediate-good-intensive final good sector with larger dynamic increasing returns leads the otherwise trapped economy to take off. Although growth requires protection, the degree of it can be gradually reduced to zero. And actually it should from the viewpoint of households.

This paper shares some features with Fung and Ishikawa (1992). First, the initial condition determines either the zero-growth or the positive-growth equilibrium. Second, starting growth in the naturally zero-growth economy requires only temporary government intervention. On the other hand, this paper departs from Fung and Ishikawa (1992) in an important respect. By incorporating intertemporal and intratemporal optimization by households, which is absent in Fung and Ishikawa (1992), this paper gives the normative criterion for the optimal government intervention. When the government takes trade policy, the optimal one is gradual, not radical, trade liberalization.

The major drawback of the model is its Ricardian production structure. Import-substituting policy necessarily results in changing the pattern of specialization, and hence the pattern of trade. However, it is the very structure that gives rise to discrete potential steady states with high or low (especially, zero) growth. As a result, this paper succeeds in explaining the East Asian policy experiences theoretically.
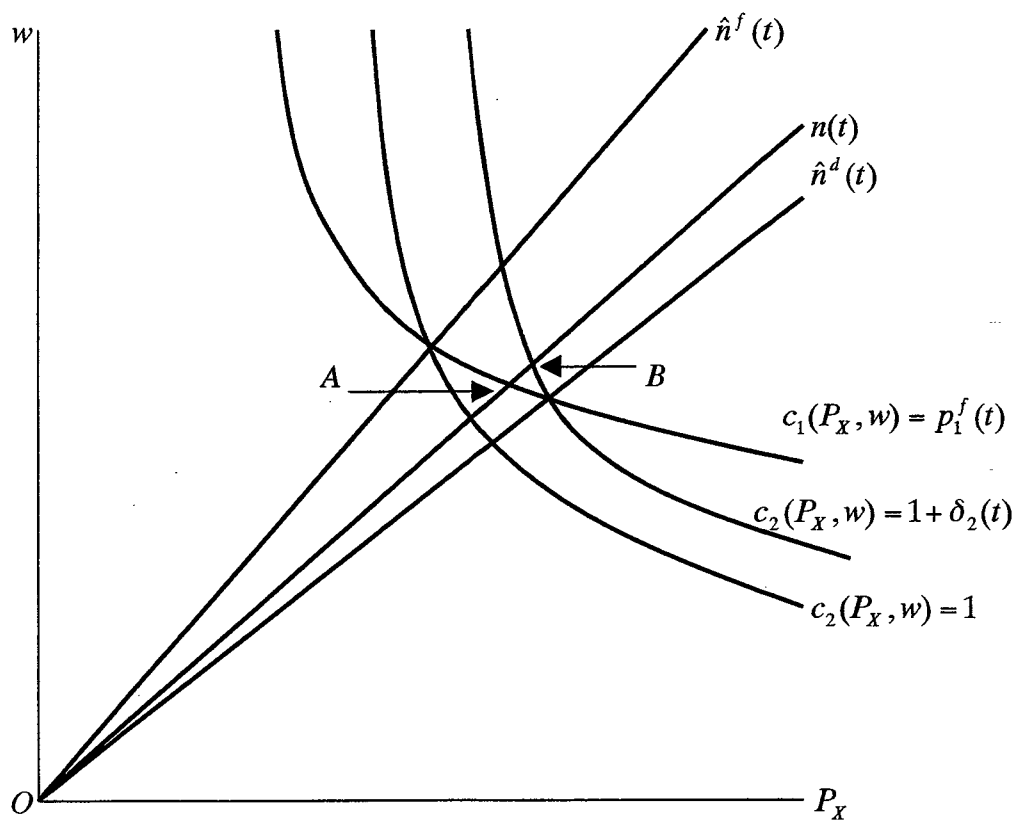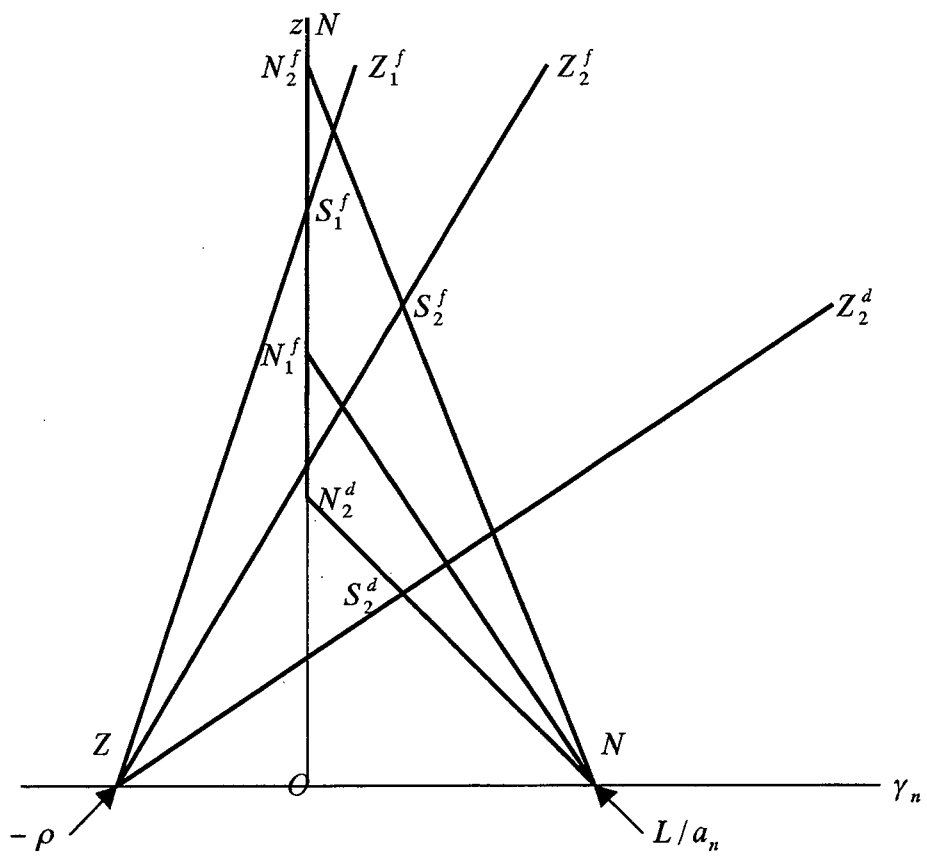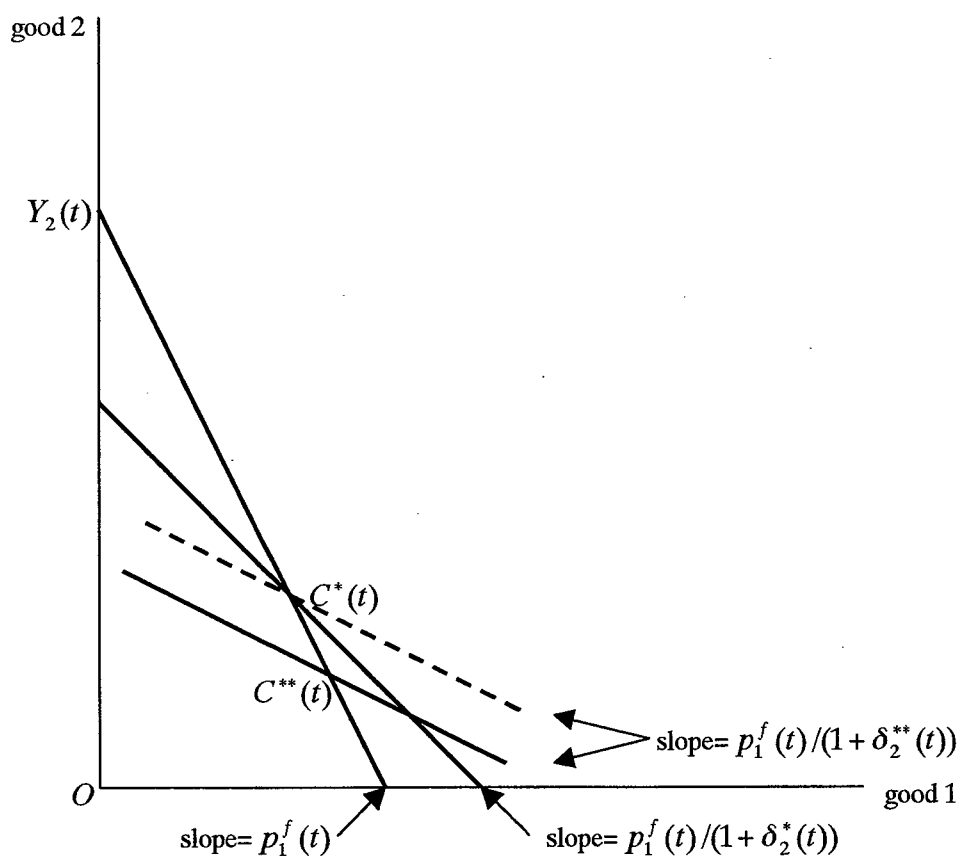
Fig. 3.1.

Fig. 3.2.

good 2

$Y_2(t)$

$C^*(t)$

$C^{**}(t)$

slope= $p_1^f(t)/(1+\delta_2^{**}(t))$

O

good 1

slope= $p_1^f(t)$

slope= $p_1^f(t)/(1+\delta_2^*(t))$

Fig. 3.3.

61

4 Conclusion

This dissertation has presented new contributions to the literature on international trade, economic growth and development. It contains one survey on the open endogenous growth theory and two chapters which analyze the effect of trade policy on growth and welfare.

Chapter 1 sorts out main issues in trade and growth. Three topics are addressed: trade policy, growth and welfare; convergence or divergence; technology transfer. First, active trade policy can be justified in terms of growth and welfare provided that the economy has some kinds of market failure such as externalities, imperfect competition, and so on. Second, convergence between North and South is likely to occur if South imports advanced technology from North in some way. Third, growth in the world is hastened by intellectual property rights protection in the case that Northern multinational corporations work as the channel of technology transfer.

Chapter 2 examines the relationships among tariff revenue, government expenditure and growth in a small open economy. The model assumes external economies in capital accumulation. If the government spends the revenue raised at customs for such a productive use as promoting the demand for capital service, which is insufficient under laissez faire, deviating from free trade is growth- and welfare-enhancing.

Chapter 3 gives a rationale for infant industry protection and gradual trade liberalization. The model assumes external economies in R&D and monopolistic competition. Depending on history and an external environment, the small open economy may fall into the poverty trap in free trade: it completely specializes in the labor-intensive good and can not grow. In this case, releasing the economy from the poverty trap requires only temporary protection of the infant industry, that is, the intermediate-good-intensive sector. Moreover, the minimum-protection type of gradual trade liberalization followed by free trade is actually the optimal trade policy.

The main contribution in this dissertation is to set out two theoretical cases in which trade intervention is good for growth and welfare of developing economies. The results obtained here coincide with the facts that some HPAEs still impose the tariff rates of more than 10% and that the tariff rates in the HPAEs are falling gradually.

Let us close this dissertation by pointing out some remaining issues which are related to the growth experience in East Asia. First, extending the North-South

endogenous product cycle models to more than two economies may generate some new insights. It is widely recognized that Japan is losing its market shares of consumer electronics and heavy industry products to the other HPAEs, which in turn are losing the share of light industry products to China and the other low-wage economies. Classifying the economies into high-income, middle-income, and low-income ones, for example, helps explain why the middle-income economies such as Korea and Taiwan are the fastest-growing of all.

Second, it is interesting to deal with changes in the composition of R&D: imitation and innovation in a developing economy. In the early phase of development after the second world war, the Japanese firms mainly imitated technology of the American firms. As the Japanese approached the world technological frontier, they began to place more importance on innovation, with the growth rate becoming lower. The other HPAEs are going to have similar experiences. How does the composition of R&D affect the growth rate? It is necessary to develop the multi-economy endogenous growth models.

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