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ABSTRACT

This paper examines the extent to which the assertion of the models of uneven development applies, which states that, under economies of scale and free trade, development of two regions (developed and developing countries) tends to be uneven. The paper presents two models which show that uneven development does not necessarily occur, if the two regions produce heterogeneous goods or if international externalities exist. In the latter case, development may be uneven, stable, or mixed, depending on relative strength of scale economies and externalities. Thus, the prospects for industrial development are not so gloomy as the models of uneven development indicate.

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1. Introduction

Recently, several papers have been published on the subject of uneven development. Krugman (1981) developed a model of international trade and growth which shows that the manufacturing sectors of two regions have a tendency to grow unevenly, resulting in a state where one of the regions becomes more industrialized than the other, with the possibility that the other region may be completely de-industrialized. Krugman presents this model as theoretical support for the doctrine of "uneven development," in which radical economists such as Baran (1954), Frank (1967) and Wallerstein (1974) argue that the current international economic system involves an inherent tendency for international inequality to increase.

The main elements in Krugman's model which cause such an unequalizing trend are the presence of scale economies in manufacturing production and the prevalence of free international trade, which together bring about cumulative industrial expansion of the early-developing region, with the exports of its manufactures crowding out the industrial sector of the latecoming region. Dutt (1986) has extended Krugman's analysis by introducing, instead of increasing returns to scale, learning by doing in industry and domestic spinoff

effects of capital accumulation in industry on labor productivity in agriculture. The former has an effect of reducing the production cost in industry; the latter increases it by increasing the wage rate. The net effect on the profitability of the manufacturing sector depends on the relative strength of these two effects. Dutt (1986) shows that, except for the case where capital accumulation in industry induces a higher labor productivity increase in agriculture than in industry, the industrial development of the two regions tend to be uneven, resulting eventually in vertical trading of manufactures from industrializing region and agricultural goods from the lagging region. Krugman (1981) and Dutt (1992) used the findings from these models to explain the industrial stagnation of India in the 18th and 19th century, especially that of the Indian textiles industry, in the face of competition from advanced foreign producers.

Although the model of uneven development may provide a useful framework to explain the industrial stagnation observed in India, the general applicability of its conclusion warrants further scrutiny. In fact, if the conclusion that interactions of countries through international trade will lead to further expansion of industrialized countries and de-industrialization of the latecomers applies to majority of the present-day developing countries, one must say that the prospects for development are extremely gloomy. However, the experiences of Japan and more recently of newly industrializing economies (NIES) of East and Southeast Asia, such as Singapore, Hong Kong, Korea, Taiwan, Malaysia and Thailand, suggest that the development prospects are not all that gloomy. In fact, the rapid industrialization being achieved by the Asian NIES seems to suggest that the conclusion of the model of uneven

development may have rather limited applicability.

The purpose of the present paper is to explore the possibility of uneven development within the extended framework of Krugman (1981). Specifically, we wish to investigate the circumstances under which, instead of uneven development, the joint growth or coexistence of the manufacturing sectors of two regions is possible. Dutt (1986) suggested one such possibility assuming the existence of a domestic spinoff effect from manufacturing to agriculture. We wish to examine other possibilities under the assumptions of free trade and the presence of economies of scale. Specifically, we shall examine two cases of trade and development for this purpose, namely, trade in heterogeneous manufactured goods and the existence of cross-country externalities such as international diffusion of knowledge. By exploring these cases, we wish to place the assertions of the models of uneven development into proper theoretical perspective.

The plan of the paper is as follows: In Section 2, Krugman's model is briefly summarized and the sources of uneven development are discussed. In Sections 3 and 4, alternative models with different market configurations and technological specifications are presented, and the properties of the long run growth are investigated and contrasted with those of the Krugman model. Finally, in Section 5, there is a brief conclusion.

2. An Overview of Krugman's Model and the Sources of Uneven Development

Krugman (1981) considers a world consisting of two regions, called North and South, both of which have two sectors, agriculture and manufacturing. The two regions are characterized by identical

technology, endowed with a fixed amount of labor, and trade their products freely. The agricultural sector produces an agricultural commodity using labor inputs and a constant returns technology. The manufacturing sector produces a manufactured good using labor and capital. The technology in the manufacturing sector is assumed to be of the Leontief type, but capital and labor coefficients are assumed to decrease with capital accumulation due to technological externalities among firms which show up as increasing returns to scale for the industry. A constant fraction of the wage income is assumed to be spent on the consumption of agricultural goods and the rest on manufactured goods. The profit incomes of the manufacturing sector are all invested for capital accumulation in that sector.

Following Krugman's notations, the model is described as follows (subscripts denote North and South):

Labor supply (L)

$$L_N = L_S = \bar{L} \tag{1}$$

Capital and labor coefficients (c and v)

$$c_N = c(K_N), \quad v_N = v(K_N)$$
$$c_S = c(K_S), \quad v_S = v(K_S), \tag{2}$$

where $c(\cdot)$ and $v(\cdot)$ are common functions giving capital and labor coefficients as functions of accumulated capital stock, with $c'(\cdot) < 0$ and $v'(\cdot) < 0$ (presence of scale economies).

Production in the Manufacturing Sector (M)

$$M_N = \frac{K_N}{c(K_N)}, \qquad M_S = \frac{K_S}{c(K_S)} \tag{3}$$

Agricultural Production (A)

$$A_N = \bar{L} - v_N M_N, \qquad A_S = \bar{L} - v_S M_S, \tag{4}$$

where agriculture is assumed to be the residual claimant of labor, and the units are chosen so that one unit of labor produces one unit of agricultural commodity. Thus, the wage rate is 1 in the agricultural good.

Maximum Capital Accumulation (definition of K_{max})

$$\frac{v(K_{max})\ K_{max}}{c(K_{max})} = \bar{L}, \tag{5}$$

which defines the level of capital stock that exactly absorbs the entire labor supply $\bar{L}$ of the region in manufacturing.

Equilibrium in the Manufactured-Good Market

$$p_M\ (M_N + M_S) = 2\gamma\bar{L}, \tag{6}$$

where the fraction γ of the wage income of two regions ($2\bar{L}$) is assumed to be spent on manufactured goods (here γ is used instead of μ by Krugman). p_M is the price of manufactured goods measured in agricultural goods.

Profit Rates (ρ)

$$\rho_N = \frac{p_M M_N - v_N M_N}{K_N} = \frac{p_M - v_N}{c_N}$$
$$\rho_S = \frac{p_M M_S - v_S M_S}{K_S} = \frac{p_M - v_S}{c_S} \tag{7}$$

Capital Accumulation ($\dot{K}/K$)

$$\frac{\dot{K}_N}{K_N} = \rho_N, \quad \text{and}$$
$$\frac{\dot{K}_S}{K_S} = \rho_S, \tag{8}$$

where capital goods are assumed to be identical with agricultural goods and produced by labor alone.

From this model, the price of manufactured good is obtained as a

function of the capital stock in the two regions:

$$p_M = 2\gamma\bar{L} \,/\, [K_N/c(K_N) + K_S/c(K_S)] \tag{9}$$

Hence, the rates of capital accumulation also become functions of the two regions' capital stock:

$$\frac{\dot{K}_N}{K_N} = g_N(K_N, K_S),$$
$$\frac{\dot{K}_S}{K_S} = g_S(K_N, K_S). \tag{10}$$

Capital accumulation in one region works to reduce the profit rate and the rate of capital accumulation in the other region, because it increases the commodity supply and reduces the price of manufactured goods. On the other hand, an increase in the domestic capital stock affects the domestic industry in two ways: it reduces the output price, and also it reduces the capital and labor coefficients due to scale economies and reduces the production cost. Whether the price-reducing effect of capital accumulation is stronger than the cost-reducing effect cannot be a priori ascertained. Krugman assumes that the former outweighs the latter.[1)] That is, he assumes that the scale economies are relatively weak, so that capital accumulation in one region reduces the profit rate and the rate of capital accumulation in that region as well (though presumably less than in the other region).

Based on these assumptions, Krugman shows that the dynamic growth of the two regions tends to be uneven. As shown in Figure 1, the growth of the two manufacturing sectors from an arbitrary initial point tends to move toward continuous expansion of one manufacturing sector and continuous contraction of the other. The result is that either only one region becomes industrialized with the other region being completely

de-industrialized (specializing in agriculture), or one region completely specializes in manufacturing with the other region becoming partially but less industrialized than the leading region. Thus, the world becomes dichotomized into regions which are more and less industrialized. This conclusion is obtained even if the two regions have access to identical technology and are endowed with identical labor forces. A similar tendency for uneven development was found by Kubo (1986) within the context of development between urban and rural sectors.

There are two important elements in Krugman's model which contribute to uneven development, namely, economies of scale and free trade in agricultural and manufactured goods. Economies of scale benefits the expanding sector by reducing capital and labor requirements, resulting in cost reduction and increases in profits. This contributes to increasing the rate of capital accumulation. Free trade links the two manufacturing sectors through the commodity market where the price of the manufactured-good is determined. An expansion of one region's manufacturing sector increases the supply of the good which, with the given demand conditions, reduces the price of the manufactured good. This change in price is transmitted to both regions, and works to reduce the profit rate and the rate of capital accumulation in the two regions. The negative effect arises because the two regions are competing in the same market.

Dutt (1986) introduced different elements in the model of uneven development. Instead of scale economies, he assumed learning by doing in industry, but this substitution does not affect the main conclusion significantly. What makes his model different is the introduction of

domestic spinoff effects, through which capital accumulation in the manufacturing sector induces an increase in agricultural labor productivity. This increase in agricultural labor productivity increases the wage rate and works to reduce the profit rate and the rate of capital accumulation in the two manufacturing sectors. Thus, apart from the price effect, capital accumulation in one region brings about the cost-reducing effect through learning by doing and the wage-increasing effect through domestic spinoff effects. If the former dominates, the accumulation of capital in one region is beneficial to itself since it increases the profit rate; if the latter dominates, then capital accumulation in a region is harmful to itself since it reduces the profit rate. The price effect is the same as before; an increase in the capital stock of one region increases the commodity supply and reduces the price, which works to reduce the profit rate in both regions. The overall outcome depends on the relative strength of these forces. Dutt (1986) shows that, if the spinoff effect to agriculture is stronger than the learning by doing effect in manufacturing, a stable development of the two manufacturing sectors results, while if the learning effect is stronger than the spinoff effect, uneven development of the two regions results.

A comparison of the two models reveals the important sources of uneven development. First, given free trade, the key to uneven development is whether or not an expansion of one region's manufacturing sector induces a net cost-reducing effect on itself. If it does, uneven development occurs; if not, a stable development will result. Hence, the first important element is whether the net cost-reducing effect of capital accumulation is present in the manufacturing sector or not.

The second important element is the negative effect of capital accumulation through the commodity market. This effect arises because the two regions compete in the same manufactured-goods market. As the supply increases in response to capital accumulation, the price of the manufactured good declines, which works to reduce the profit rate and the rate of capital accumulation in both regions. Depending on the level of capital accumulation in the two regions, there is a range of the price which makes one region's profit rate positive and the other region's profit rate negative, and this difference is what leads to uneven development. In fact, in Krugman's model, uneven development occurs even if there are no scale economies, as long as there is something which causes a difference in the profitability of the two regions.[2)] The negative price effect affects the two regions alike because they produce an identical manufactured commodity and compete in the same product market.

Having identified the main sources of uneven development in these models, we can now consider the factors that may alleviate uneven development and bring about even development or coexistence of the two regions. Dutt (1986) suggested one such possibility by introducing the domestic spinoff effect from industry to agriculture. Another possibility is the production of heterogeneous goods. The negative price effect arose because the two regions competed in the same commodity market. If they produce different commodities and if a certain fraction of wages incomes is spent on each manufactured good, the two regions will be able to coexist by supplying to both regions.

A third possibility is the existence of a beneficial effect of one region's capital accumulation on the production cost of the other

region. For example, if there is an international diffusion of knowledge, then an accumulation of capital in one region might exert external economies on the other region in the form of reduced labor and capital requirements, and increase the profit rate and the rate of capital accumulation in the latter region. Thus, industrial expansion in one region would induce an expansion of the other region, suggesting a possibility of joint growth of the two regions.

In the next two sections, we shall examine the models of growth which incorporates heterogeneous manufactured goods and international external economies in turn.

3. Production of Heterogeneous Manufactured Goods

Starting from the Krugman model in Section 2, suppose that the manufactured goods produced in the two regions are heterogeneous, but they are traded freely between the regions. The manufacturing production in the two regions are described by (2) and (3) as before, but now M_N and M_S denote different commodities. Hence, separate equilibrium conditions must hold for the two goods. In each region, assume that fixed fractions, γ and δ, of the wage incomes are spent on the consumption of the North and the South manufactured goods, respectively. Then the equilibria in the goods markets require that

$$p_N M_N = \gamma(L_N + L_S) = 2\gamma\bar{L}, \quad \text{and}$$
$$p_S M_S = \delta(L_N + L_S) = 2\delta\bar{L}, \tag{12}$$

where p_N and p_S are the prices of the North and the South manufactured goods. Then, in view of (2) and (3), the manufactured-good prices become functions of each region's capital stock alone:

$$p_N = 2\gamma\bar{L}/[K_N/c(K_N)]$$
$$p_S = 2\delta\bar{L}/[K_S/c(K_S)] \tag{13}$$

The capital accumulation functions are given as before by (8), which, in view of (7) and (13), can be written as

$$\dot{K}_N/K_N = \rho_N = (p_N - v_N)/c_N = 2\gamma\bar{L}/K_N - v(K_N)/c(K_N)$$
$$\dot{K}_S/K_S = \rho_S = (p_S - v_S)/c_S = 2\gamma\bar{L}/K_S - v(K_S)/c(K_S) \tag{14}$$

Here, for simplicity, we shall assume that scale economies are neutral in the sense that

$$v(K_N)/c(K_N) = b/a = \text{const.} = v(K_S)/c(K_S) \tag{15}$$

The long-run equilibrium of the economy, given when $\dot{K}_N = 0$ and $\dot{K}_S = 0$ is depicted in Figure 2. As we can see from (14) and (15), the $\dot{K}_N/K_N = 0$ and $\dot{K}_S/K_S = 0$ curves are given by

$$K_N = 2a\gamma\bar{L}/b, \quad \text{and}$$
$$K_S = 2a\delta\bar{L}/b, \tag{16}$$

respectively, which are horizontal and vertical lines in the (K_S, K_N) plane. $\dot{K}_N/K_N$ is negative above the $\dot{K}_N/K_N = 0$ curve and positive below the curve. $\dot{K}_S/K_S$ is negative to the right of the $\dot{K}_S/K_S = 0$ curve and positive to the left. It is obvious from Figure 2 that the long-run equilibrium is stable, and any path which starts from an arbitrary initial point will lead to a state where the manufacturing sectors of the two regions achieve certain stable sizes. Which manufacturing sector becomes larger depends on the fractions γ and δ of the wage incomes that are spent on the North and South manufactured goods.

The implication of this simple model is that, if the two regions do

not compete in the same manufactured good, but specialize in different (composite) manufactured goods, then, the joint industrialization of the two regions are possible, even if both manufacturing production are characterized by increasing returns to scale. Thus, here is one circumstance under which uneven development does not occur. That is, the developing countries can choose to produce manufactured goods which do not directly compete with the products of the advanced industrialized nations. It could be a product based on particular resources with which the country is endowed, or it could be the lower end of a product line which the developing countries can produce at a lower cost using their relatively cheap labor. Since the markets are separated, industrial expansion of one region does not adversely affect the other region through the market, enabling the developing countries to maintain the profitability to continue the accumulation of capital in their own industry.[3)]

4. Existence of International External Economies

Another circumstance under which uneven development may not occur is the existence of international externalities, which may arise from diffusion of knowledge and information from one region to another. International exchange of workers and professionals, transmission of technical information through professional journals and documents, and the ability to imitate and reproduce products from foreign countries will all contribute to improving efficiency in production and reducing costs. The model presented in this section aims at examining what will happen to the growth of the two regions under the existence of such international external economies.[4)]

We start from the basic Krugman model in which the manufacturing sectors of the two regions produce the same good, but now we assume that the manufacturing technology is characterized not only by scale economies but also by international externalities so that capital accumulation in one region results in a reduction of capital and labor requirements in the other region. We shall assume simple forms of such scale economies and international external economies, and assume that the capital and labor coefficients in the two regions are given by

$$c_N = \frac{a}{K_N^{\alpha} K_S^{\lambda}}, \qquad v_N = \frac{b}{K_N^{\alpha} K_S^{\lambda}},$$
$$c_S = \frac{a}{K_S^{\alpha} K_N^{\mu}}, \qquad v_S = \frac{b}{K_S^{\alpha} K_N^{\mu}}, \tag{17}$$

where the subscripts denote North and South, c and v denote capital and labor coefficients, α the degree of scale economies, and λ and μ the degrees of international external economies. We assume that

$$0 < \alpha < 1, \quad 0 < \lambda, \mu < 1, \text{ and } 0 < a, b$$

The fact that the same a, b and α apply to regions N and S means that the two regions are exposed to the same basic technology with the same degree of scale economies. Note that we have assumed neutrality in the scale economies and externalities in the sense that

$$c_N/v_N = a/b = \text{const.}, \text{ and } c_S/v_S = a/b = \text{const.} \tag{18}$$

However, we have allowed for a difference in the strength of international external economies between the two regions.

Given the technological coefficients in (17), the manufacturing production in the two regions are given by

$$M_N = K_N/c_N = a^{-1} K_N^{1+\alpha} K_S^{\lambda},$$
$$M_S = K_S/c_S = a^{-1} K_S^{1+\alpha} K_N^{\mu} \tag{19}$$

The assumptions on labor supply and agricultural production are the same as before. To reiterate, the two regions are endowed with the same amount of labor, $\bar{L}$:

$$L_N = L_S = \bar{L}$$

The agricultural sector is the residual claimant of labor, and produces an agricultural commodity using labor inputs and constant returns technology. We choose the unit of measurement so that one unit of agricultural labor produces one unit of agricultural commodity, and write the agricultural production as

$$\begin{aligned} A_N &= \bar{L} - v_N M_N, \\ A_S &= \bar{L} - v_S M_S. \end{aligned} \tag{20}$$

This specification implies that the wage rate is set equal to 1 in the agricultural commodity.

Let p_M be the price of the manufactured good in terms of the agricultural good. Assuming that a fraction γ of the wage incomes are spent on the consumption of manufactured goods, equilibrium in the manufactured-good market is attained when

$$p_M (M_N + M_S) = 2\gamma\bar{L}, \tag{21}$$

which, in view of (19), gives the price of the manufactured good as

$$p_M = 2a\gamma\bar{L}/[K_N^{1+\alpha} K_S^{\lambda} + K_S^{1+\alpha} K_N^{\mu}] \tag{22}$$

The profit rate in each region is given by

$$\begin{aligned} \rho_N &= (p_M - v_N)/c_N = p_M/c_N - b/a \\ \rho_S &= (p_M - v_S)/c_S = p_M/c_S - b/a \end{aligned} \tag{23}$$

Profit incomes in each region are assumed to be reinvested in that region. Hence, in view of (17), (22), and (23), capital accumulation functions for the two regions are given by

$$\dot{K}_N/K_N = \rho_N = p_M/c_N - b/a = 2\gamma\bar{L}/[K_N + (c_N/c_S)K_S] - b/a$$

$$\dot{K}_S/K_S = \rho_S = p_M/c_S - b/a = 2\gamma\bar{L}/[K_S + (k_S/c_N)K_N] - b/a.$$

Note that, from (17),

$$c_N/c_S = K_N^{\mu-\alpha} K_S^{\alpha-\lambda}.$$

Hence, the capital accumulation functions become

$$\begin{aligned} \dot{K}_N/K_N &= 2\gamma\bar{L}/[K_N + K_S^{1+\alpha-\lambda} K_N^{\mu-\alpha}] - b/a \\ \dot{K}_S/K_S &= 2\gamma\bar{L}/[K_S + K_N^{1+\alpha-\mu} K_S^{\lambda-\alpha}] - b/a. \end{aligned} \tag{24}$$

The long-run equilibrium of the economy is attained when $\dot{K}_N/K_N = 0$ and $\dot{K}_S/K_S = 0$. Note that from (24), $\dot{K}_N/K_N = 0$ and $\dot{K}_S/K_S = 0$ are equivalent to

$$K_S^{1+\alpha-\lambda} = (2a\gamma\bar{L}/b - K_N) K_N^{\alpha-\mu}, \tag{25}$$

and

$$K_N^{1+\alpha-\mu} = (2a\gamma\bar{L}/b - K_S) K_S^{\alpha-\lambda} \tag{26}$$

respectively. From these equations, the following properties can be easily derived:

Property 1: The $\dot{K}_N/K_N = 0$ curve has the following properties:

(i) If $\alpha > \mu$, the $\dot{K}_N/K_N = 0$ curve passes through (0, 0) and $(0, 2a\gamma\bar{L}/b)$ in the (K_S, K_N) plane, and is upward-sloping for the values of K_N between 0 and $(\frac{\alpha-\mu}{1+\alpha-\mu})(\frac{2a\gamma\bar{L}}{b})$, and downward sloping for the values of K_N between $(\frac{\alpha-\mu}{1+\alpha-\mu})(\frac{2a\gamma\bar{L}}{b})$ and $\frac{2a\gamma\bar{L}}{b}$.

(ii) If $\alpha < \mu$, the $\dot{K}_N/K_N = 0$ curve passes through $(0, 2a\gamma\bar{L}/b)$ in the (K_S, K_N) plane, and is downward-sloping and approaches the horizontal (K_S) axis as K_N approaches 0.

(iii) $\dot{K}_N/K_N > 0$ to the left of this curve and $\dot{K}_N/K_N < 0$ to the right of this curve.

Property 2: The $\dot{K}_S/K_S = 0$ curve has the following properties:

(i) If $\alpha > \lambda$, the $\dot{K}_S/K_S = 0$ curve passes through (0, 0) and $(2a\gamma\bar{L}/b, 0)$ in the (K_S, K_N) plane, and is upward-sloping for the values of K_S between 0 and $(\frac{\alpha-\lambda}{1+\alpha-\lambda})(\frac{2a\gamma\bar{L}}{b})$, and downward-sloping for the values of K_S between $(\frac{\alpha-\lambda}{1+\alpha-\lambda})(\frac{2a\gamma\bar{L}}{b})$ and $\frac{2a\gamma\bar{L}}{b}$.

(ii) If $\alpha < \lambda$, the $\dot{K}_S/K_S = 0$ curve passes through $(2a\gamma\bar{L}/b, 0)$ in the (K_S, K_N) plane, and is downward-sloping and approaches the vertical (K_N) axis as K_S approaches 0.

(iii) $\dot{K}_S/K_S > 0$ below this curve and $\dot{K}_S/K_S < 0$ above this curve.

A question remains as to whether or not these curves have an intersection. By equating (25) and (26), we find [5]

$$K_N = K_S^{(\alpha-\lambda)/(\alpha-\mu)} \tag{27}$$

For the purpose of the present study, we will assume that $\alpha \neq \lambda$ and $\alpha \neq \mu$.[6] Substituting (27) into (25) and rearranging, we obtain

$$K_S^{(\alpha-\lambda)/(\alpha-\mu)} + K_S = 2a\gamma\bar{L}/b. \tag{28}$$

If $(\alpha-\lambda)/(\alpha-\mu) > 0$, then the left-hand side of (28) ranges from 0 to ∞, and there is a unique K_S which satisfies (28). This value is larger, the larger the value of $2a\gamma\bar{L}/b$ and the smaller the value of $(\alpha-\lambda)/(\alpha-\mu)$. (28) can alternatively be written as

$$K_N + K_S = 2a\gamma\bar{L}/b. \tag{29}$$

Hence, the intersection of the $\dot{K}_N/K_N = 0$ and $\dot{K}_S/K_S = 0$ curves lies on

the line segment connecting $(2a\gamma\bar{L}/b, 0)$ and $(0, 2a\gamma\bar{L}/b)$.

If $(\alpha-\lambda)/(\alpha-\mu) < 0$, then the left-hand side of (16) is the sum of the 45° line and a monotone transformation of a rectangular hyperbola, which approaches ∞ as K_S approaches 0 or ∞ and has a minimum at

$$K_S = (-\frac{\alpha-\mu}{\alpha-\lambda})^{(\alpha-\mu)/(\mu-\lambda)} \tag{30}$$

The minimum value can be calculated as

$$(\frac{\mu+\lambda}{\alpha-\mu})(-\frac{\alpha-\mu}{\alpha-\lambda})^{(\alpha-\mu)/(\mu-\lambda)} .$$

If this value is less than $2a\gamma\bar{L}/b$, then (28) has two solutions, so that the $\dot{K}_N/K_N = 0$ and $\dot{K}_S/K_S = 0$ curves have two intersections in the (K_S, K_N) plane. Thus, we have proved the following property:

Property 3:

(i) If $\alpha > \mu$ and $\alpha > \lambda$, or if $\alpha < \mu$ and $\alpha < \lambda$, then the $\dot{K}_N/K_N = 0$ and $\dot{K}_S/K_S = 0$ curves have a unique intersection $(\hat{K}_S, \hat{K}_N)$, which lies on the line segment $K_N + K_S = 2a\gamma\bar{L}/b$. The larger the value of $(\alpha-\lambda)/(\alpha-\mu)$, the smaller the value of $\hat{K}_S$ and the larger the value of $\hat{K}_N$.

(ii) If $(\alpha-\lambda)/(\alpha-\mu) < 0$, the $\dot{K}_N/K_N = 0$ and $\dot{K}_S/K_S = 0$ curves have two intersections if and only if

$$2a\gamma\bar{L}/b > (\frac{\mu-\lambda}{\alpha-\mu})(-\frac{\alpha-\mu}{\alpha-\lambda})^{(\alpha-\mu)/(\mu-\lambda)} \tag{31}$$

If equality holds, there is one intersection (tangency). Otherwise, the two curves do not intersect.

Property 3 (ii) specifies the conditions under which the $\dot{K}_N/K_N = 0$

and $\dot{K}_S/K_S = 0$ curves have only one or no intersection when $(\alpha-\lambda)/(\alpha-\mu) < 0$. However, the possibility of such an occurrence is very small, because the minimum value given by the right-hand side of (31) is very small. The left-hand side of (28) takes the value of 2 when K_S is 1, so that the minimum value is less than or at most equal to 2. For this reason, when $(\alpha-\lambda)/(\alpha-\mu) < 0$, we shall only consider the case where the $\dot{K}_N/K_N = 0$ and $\dot{K}_S/K_S = 0$ curves have exactly two intersections.

The manufacturing growth of the two regions is depicted in Figures 3-5. Figure 3 corresponds to the case where $\alpha-\mu > 0$ and $\alpha-\lambda > 0$. α is the index of scale economies; if this value is larger, the benefit of capital accumulation on the cost reduction in the own region is greater. μ is the index of externalities that the North exerts on the South. It benefits the efficiency of production in the South by reducing the labor and capital coefficients, and increases the profit rate and the rate of capital accumulation in that region. Then, in relative terms, the advantage of the North in accumulating capital stock and enhancing a faster relative industrial expansion depends on the difference $\alpha-\mu$, the difference between the degree of scale economies and the degree of international externalities the North exerts on the South. Similarly for $\alpha-\lambda$. We shall refer to these differences as net scale economies if positive and net external economies if negative. The present case of $\alpha-\mu > 0$ and $\alpha-\lambda > 0$ corresponds to the case where both regions enjoy positive net scale economies. In this case, an expansion of manufacturing industry in one region results in a net relative cost advantage of that region over the other region, so that this region will continue to expand relative to the other region. The stationary point C

is a saddle point, and the manufacturing growth of the two regions will be uneven. Point C is located closer to B, the smaller the value of $(\alpha-\lambda)/(\alpha-\mu)$. That is, the larger the net scale economies $\alpha-\mu$ of North relative to that $(\alpha-\lambda)$ of South, the closer the stationary point C to point B, and the possibility of eventual industrial expansion of the North and de-industrialization of the South increases. If $(\alpha-\lambda)/(\alpha-\mu)$ is larger, the reverse possibility increases.

Figure 4 corresponds to the case where $\alpha-\mu < 0$ and $\alpha-\lambda < 0$. In this case, the external effect exerted by each region is stronger than the effect of the scale economies within each region. This will happen if the degree of scale economies is very low but there are some degrees of international externalities. As we can see from Figure 4, the manufacturing growth of the two regions are stable in this case, and any path starting from an arbitrary initial point leads to the stationary point C, where the two regions achieve certain stable sizes. The stationary point C locates closer to point A, the larger the value of $\mu-\alpha$ and smaller the value of $\lambda-\alpha$. That is, the region which receives larger net externalities will achieve a larger equilibrium size.

Finally, Figure 5 corresponds to the case where $\alpha-\mu < 0$ and $\alpha-\lambda > 0$ and where the $\dot{K}_N/K_N = 0$ and $\dot{K}_S/K_S = 0$ have two intersections. In this case, there are three stationary points, but only two of them, C and A, are stable and D is unstable (a saddle point). There are threshold paths that lead to stationary point D. If the two-region economy starts from an initial point which is located to the right of the threshold paths, then it will approach point C, where the two regions attain stable manufacturing sizes. If the economy starts from a point to the

left of the threshold paths, it will approach B, where only the North attains a positive manufacturing size. If $\alpha-\mu > 0$ and $\alpha-\lambda < 0$, then the opposite development pattern will emerge.

As we have seen above, when there are international external economies, the industrial development of the two regions may not necessarily become uneven. If domestic scale economies are dominant, uneven development will result. If scale economies are relatively weak and if stronger international externalities exist, the development of the two regions is stable, with the two regions achieving certain equilibrium sizes. Finally, if one region has positive net scale economies and the other has negative net scale economies, a mixture of the above two patterns will arise and, provided that it starts from an appropriate initial point, the two-region economy will approach a long-run equilibrium where both regions achieve stable manufacturing sizes but where one region is more industrialized than the other. Thus, in the present case of international external economies, uneven development with de-industrialization of the latecomers is not the necessary theoretical consequence.

An interesting interpretation of the above development patterns can be made. If the two regions, North and South, compete in the industry which has strong scale economies and small external economies, uneven development results. Examples of such industries may be steel, automobiles, computers, and so on, where there are large economies of scale but the technologies are difficult to transfer, imitate or master. In such cases, the advantages of the early developers tend to dominate, and the development of these industries in the developing countries tend to be difficult. On the other hand, if the two regions compete in the

industry where scale economies are small but external economies are relatively large, the latecoming region can also achieve a certain industrial size. Examples of such industries may be textiles, clothing, assembly of electrical and electronics products, wood products, etc., where economies of scale are relatively weak and acquisition and mastery of the technology and imitation of the foreign produced commodities are relatively easy. In these industries, the latecomers can also attain certain sizes, without being de-industrialized by the advanced industrial nations.

When we compare the developed and developing countries, the cross-country externalities from the developing to developed countries may be very weak. That is, λ will probably be very small. On the other hand, if the developing countries can learn and absorb the knowledge, technology and information quickly and efficiently, μ can be large. Hence, with a technology which is characterized by a moderate degree of scale economies, the possibility of having the case depicted in Figure 5, where $\alpha-\mu < 0$ and $\alpha-\lambda > 0$, becomes fairly high. That is, the development of the two regions may lead to a stable equilibrium where the latecoming South achieves a larger equilibrium size in this industry than the early-developed North. Of course, there are threshold paths, so that the relative initial sizes matter, and the big-push type efforts may be necessary, but much brighter prospects for industrialization of the developing countries are suggested by the present case, than are indicated by the models of uneven development.

The parameter μ denotes the degree to which the South benefits from externalities from the developed North. We can interpret this as indicating the ability to absorb and utilize the knowledge and

information transmitted from the North for improving efficiency in production in the South. Such an ability will definitely be dependent on the level of education of the workers and managers. The higher this ability, the greater is the possibility that the developing countries can achieve industrialization even in industries that are characterized by higher degrees of scale economies, since a larger μ will enable $\alpha-\mu < 0$ for a larger value of α. That is, developing countries with higher education and higher absorptive capacity of the workers have higher possibility for succeeding in industrialization even in industries where there are relatively strong economies of scale. The successful industrialization of Japan, Singapore, Hong Kong, Korea, Taiwan, and Malaysia appears to render support for the above association of the industries to develop and the absorptive capacity of the workers. These economies started their industrialization from light industries such as textiles, clothing, wood products and assembly of electrical and electronics products, where economies of scale are relatively weak and the acquisition and imitation of technology is relatively easy. With the experiences gained in these industries, the countries moved into industries such as automobiles, steel, and high-tech electronics products, where economies of scale are larger and the acquisition and imitation of the technology is more difficult. The fact that these countries have made successful inroads into some or all of these "late" industries suggest that the absorptive capacity of the labor force was high enough to outweigh the opposing force toward uneven development induced by the existence of economies of scale.

5. Conclusion

In this paper, we have examined the possibility of uneven development under the assumptions of free trade and economies of scale. The aim of the paper was to examine the extent to which Krugman's (1981) assertion of uneven development applies, which states that, under free trade and economies of scale, the development of two industrializing regions tends to be uneven, leading to industrialization of one region and de-industrialization of the other, unless resource endowment conditions preclude complete de-industrialization of the lagging region. We have examined the sources that bring about such uneven development, and explored the possibility that uneven development can be avoided within an extended framework of Krugman's model. One such possibility was suggested by Dutt (1986), who introduced domestic spinoff effects from industry to agriculture and learning by doing in industry into the model of uneven development. In his model, if the domestic spinoff effect overwhelms the learning by doing effect, the development of the two regions is stable, and uneven development can be avoided. In this paper, we have examined two other possibilities. Firstly, we have shown that, in an extended Krugman model where the two regions produce heterogeneous manufactured goods, uneven development does not occur, even if the two regions are characterized by increasing returns to scale. This is because capital accumulation in one region does not exert negative influence on the profit rate of the other region, since the two regions are not linked through the commodity market. An implication of this analysis is that one way for the developing countries to avoid uneven development is to choose manufacturing products which do not directly compete with the products that advanced

industrialized nations produce. It could be a product based on particular resources the country is endowed, or it could be the lower end of the product line which the developing countries can produce at a lower cost using their relatively cheap labor. By doing so, the industries in the developed and developing countries can coexist by "specializing" in different types of manufactured goods.

Secondly, we have shown that, if, in addition to scale economies, international externalities are present, uneven development does not necessarily result. In this case, the development of the two regions may be uneven, stable, or a mixture of the two, depending on the relative strength of scale economies and international externalities. If scale economies are stronger than the international externalities which each region exerts on the other, the development will be uneven and one of the regions will be de-industrialized. If the scale economies are relatively weak and the international externalities are stronger, the development will be stable, and the two regions will achieve stable manufacturing sizes. Finally, if the scale economies dominate in one region, but international externalities are stronger in the other region, the development will be a mixture of the above two cases. In this case, there are threshold paths, and depending on the initial capital stock, the two-region economy may approach a stable equilibrium where two regions achieve certain stable sizes, or it may approach a point where only one region is industrialized and the other is de-industrialized. Therefore, when there are international externalities, uneven development of the two regions is not the necessary theoretical consequence, and there is a room for developing countries to achieve industrialization without being de-industrialized

by the advanced industrial countries.

In applying the above findings to developed and developing countries, we note that international externalities from developing to developed countries are expected to be very small. On the other hand, the extent to which developing countries can benefit from externalities from developed countries depends on the ability of the workers and managers in the developing countries to absorb and utilize the information transmitted from the developed countries for improving production efficiency. Such ability will definitely be dependent upon the level of education of the workers and managers in each country. If the absorptive capacity is larger, the international externalities from which developing countries can benefit will be larger. Then, with the production technology characterized by a modest degree of scale economies, the possibility is high that we have the case of mixed development, in which the two-region economy may lead to a stable equilibrium where the latecoming South can achieve a larger industrial size than the early-developed North. Of course, there are threshold paths, so that the initial capital stock of the two regions matter, and a big-push type effort may be necessary on the part of the developing countries, but much brighter prospects for industrialization are suggested for developing countries than indicated by the model of uneven development.

Notes

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1) Krugman's assumption is conservative from the point of view of uneven development, in the sense that, if the opposite is the case, capital accumulation in one region increases the profit rate and the rate of capital accumulation in the own region, increasing the possibility of uneven development [Krugman (1981), p.153].

2) In Krugman's model, if capital and labor coefficients are constant but different between the two regions, the profit rates will be different for the same values of the commodity price and the tendency for uneven development still remains.

3) We have assumed neutrality in the scale economies, but the results will not change as long as the profit rate function of each region is a monotone decreasing function of the region's capital stock and ranges from positive to negative values.

4) A detailed account of the model presented in this section is given in

Kubo (1993) under a slightly different context.

5) Equating the right-hand sides of the two equations in (24), we obtain

$$K_N + K_S^{1+\alpha-\lambda} K_N^{\mu-\alpha} = K_S + K_N^{1+\alpha-\mu} K_S^{\lambda-\alpha}$$

which can be rewritten as

$$(K_N^{1+\alpha-\mu} + K_S^{1+\alpha-\lambda}) K_N^{\mu-\alpha} = (K_S^{1+\alpha-\lambda} + K_N^{1+\alpha-\mu}) K_S^{\lambda-\alpha}$$

Hence,

$$K_N^{\mu-\alpha} = K_S^{\lambda-\alpha}$$

6) When $\alpha = \mu$ and $\alpha = \lambda$, the $\dot{K}_N/K_N = 0$ and $\dot{K}_S/K_S = 0$ curves coincide, given by the downward-sloping 45° line connecting A and B. In this case, all the points on this line are stationary points, and any trajectory starting from an arbitrary initial point will tend toward a point on the line. If $\alpha = \mu$ or $\alpha = \lambda$ but not both, the phase diagrams of Figures 3 - 5 must be slightly modified, but the patterns of development will become similar to one of the three cases depicted in Figures 3-5.

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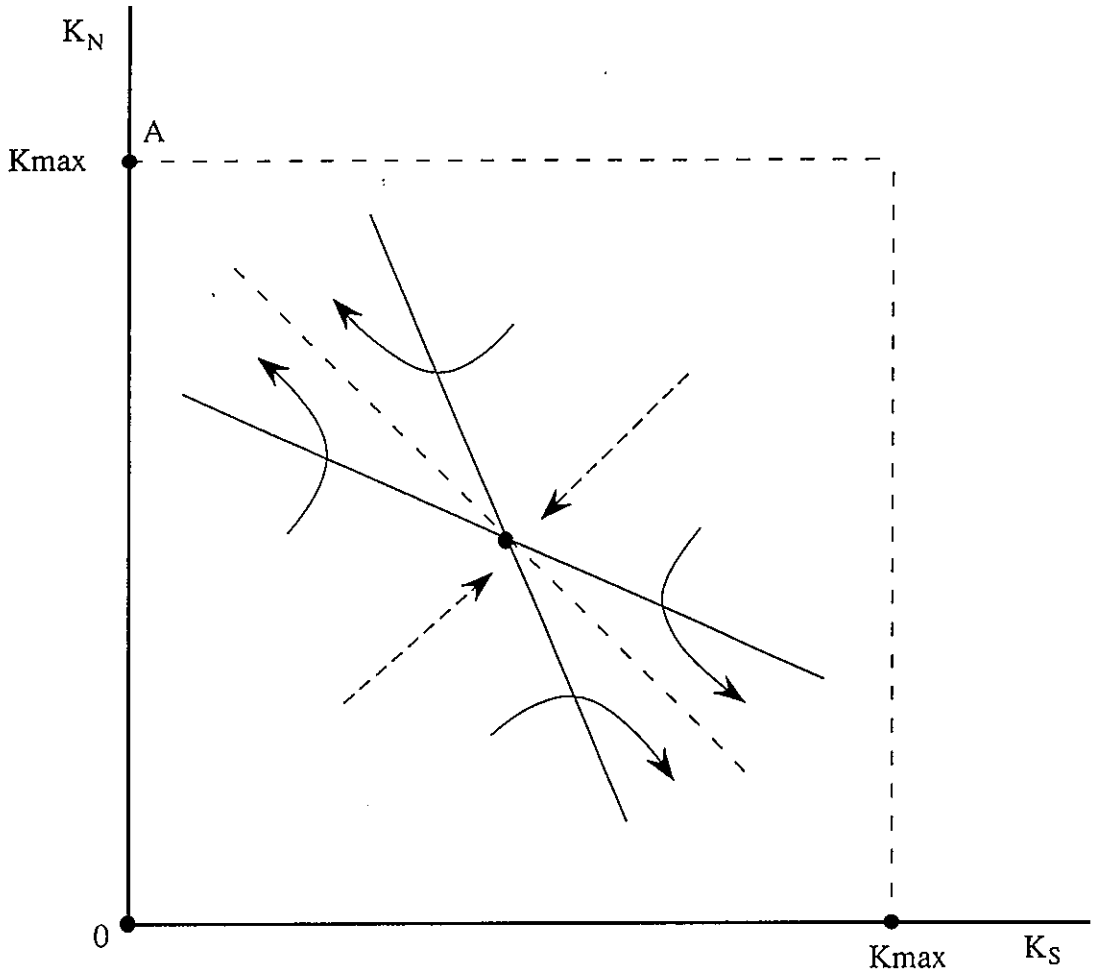

Figure 1 : Uneven Development

[Krugman(1981), Figure 1]

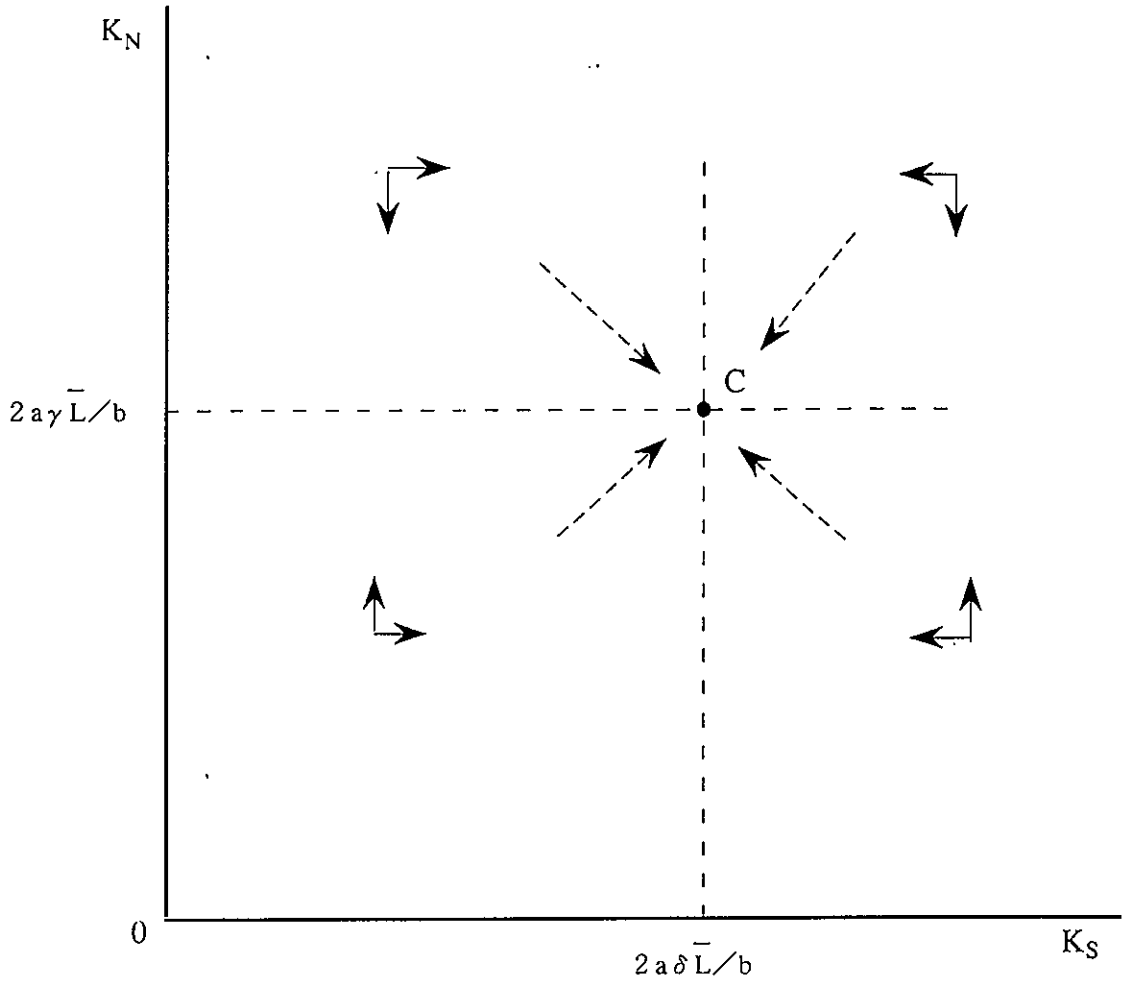

Figure 2 : Development with Heterogenous

Manufactured Goods

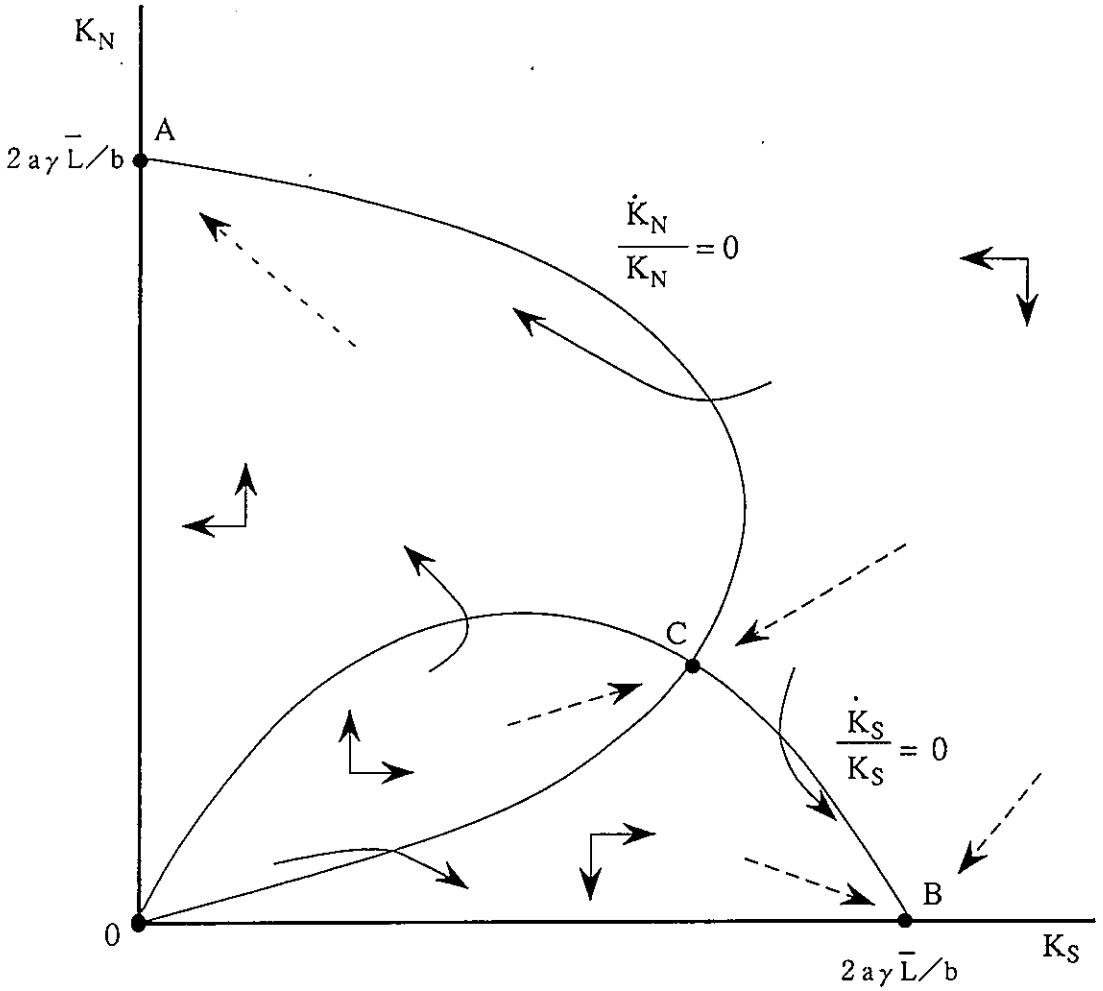

Figure 3 : Uneven Development

($\alpha > \mu$ and $\mu > \lambda$)

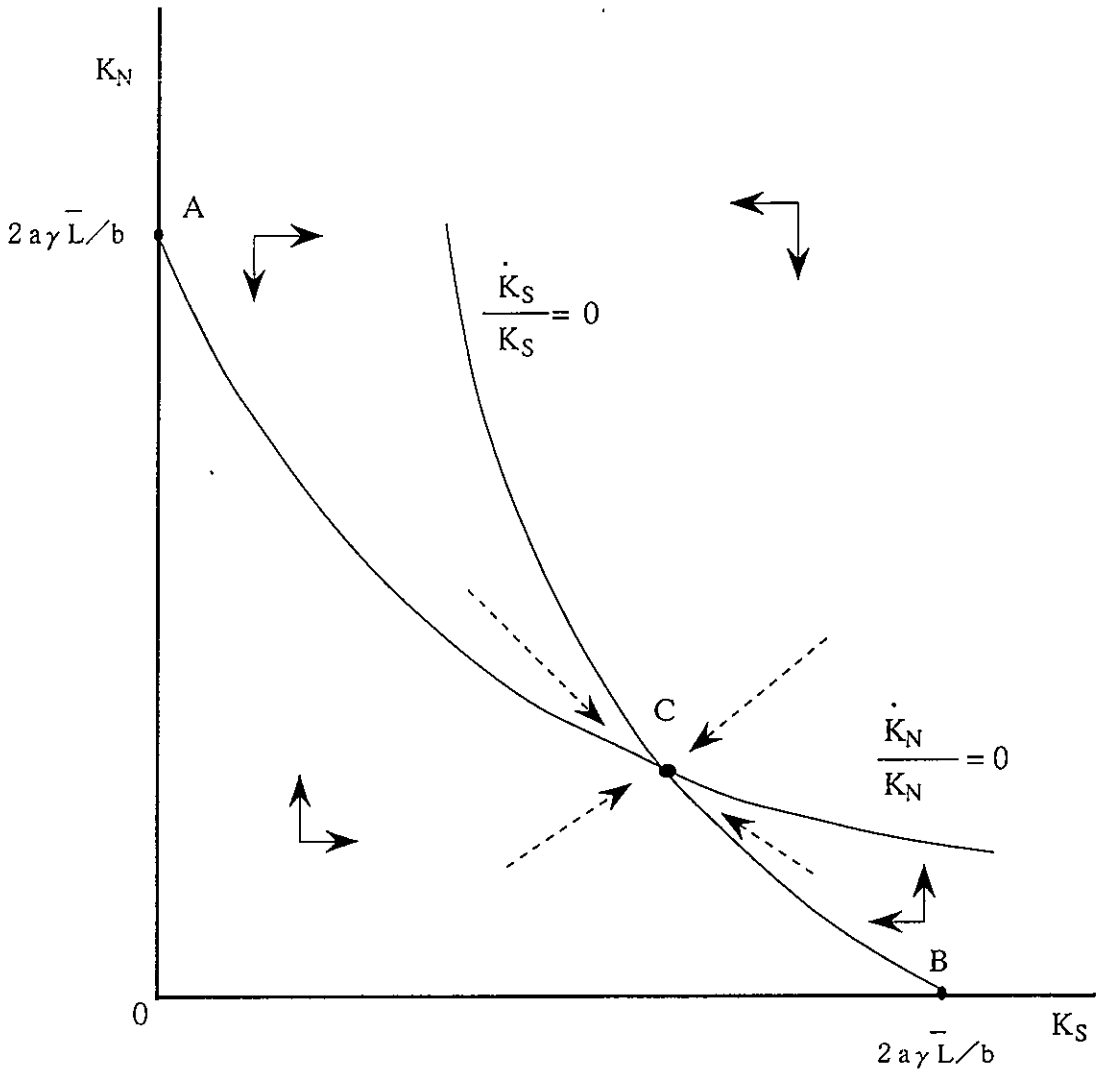

Figure 4 : Stable Development

($\alpha < \mu$ and $\alpha < \lambda$)

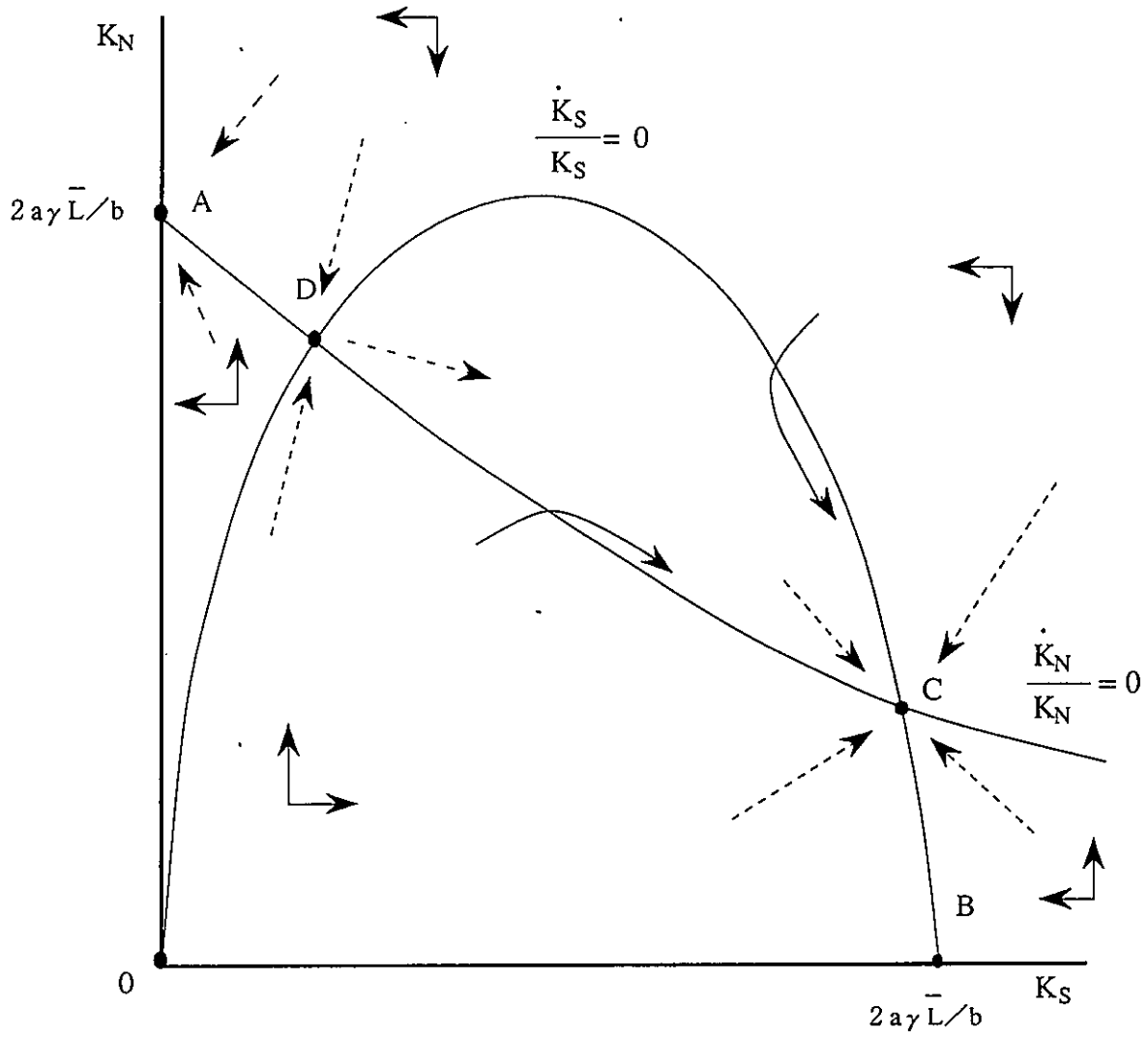

Figure 5 : Mixed Development

($\alpha < \mu$ and $\alpha > \lambda$)