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Economic Takeoffs in a Dynamic Process of Globalization

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Abstract

The paper develops a dynamic general-equilibrium framework to illustrate that trade liberalization may speed up the process of globalization and industrialization by enabling a small open economy to reallocate production factors to modern export sectors where increasing returns to experience are present. The authors emphasize the role of knowledge in service activities related to the export of modern sector goods, which has the form of a public good that can be utilized in exporting of other modern sector goods. As a consequence of this knowledge accumulation, the economy begins to take off and exhibits more rapid rates of wage and output growth. The accumulation of knowledge also shifts comparative advantage in the modern sector to more service-intensive goods, thus leading to a natural evolution of comparative advantage. These results lend theoretical support to the different development experiences in the 1960s between East Asia and Latin America.

1. Introduction

In a dynamic process of globalization, trade liberalization often lowers the tariff-adjusted price of the importable. The scenario we develop in this paper suggests that such a move towards free trade may enable a small open economy to reallocate production factors to modern export sectors where increasing returns to experience are present. As a consequence, the economy begins to take off, enjoying a more rapid rate of economic growth.[1] When the rate of accumulation in exporting experiences slows down as time goes by, economic growth declines.

The takeoff associated with trade liberalization and a shift toward outward orientation in production has been noted in a number of examples of successful growth experience. Balassa (1972) observed that the rapid growth in Taiwan and Korea in the mid-1960s was accompanied by a rapid transformation from import substitution to nontraditional exportables. In fact, in the pre-liberalization stage, both economies imposed high effective protective rates (about 100%) to ensure competitiveness of domestic producers of import substitution sectors. By the mid-1960s, however, the effective protective rates were only about 50–60% in these economies. Such a sharp drop in tariffs and removal of heavy trade barriers could have crucial implications for their miraculous development performance.[2]

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An important part of the development of the export sector is that international trade often requires specialized labor services to manage and promote foreign sales. In many East Asian economies, such activities are surprisingly organized. For example, what is called "Sogo Shosha" in Japan (as well as in Korea) is a trade association handling matching between domestic producers and international buyers (Rauch, 1996). Similar organizations, often referred to as the "auxiliary" or "supporting" industry, are also found in Hong Kong and Taiwan. These organizations serve as international brokers by exploring new foreign markets and locating best domestic manufacturers to meet high-standard international demands (Van and Wan, 1997). The essential role of knowledge accumulated in exporting has been emphasized in case studies of the success of Taiwanese machine tool firms (Amsden, 1977) and the failure of Colombian apparel producers (Morawetz, 1981).

An example of the type of spillover effects that we model, and their association with export services, is provided by the development of the garment industry in Bangladesh as discussed by Easterly (2001, ch. 8). The industry began to grow with a joint venture between a local firm and Daewoo Corporation of South Korea, which was motivated by the desire of Daewoo to find a low-wage production location that was not subject to US import quotas. This collaboration touched off an expansion in the industry that saw shirt production increase from 43,000 units in 1980 to 2.3 million units in 1987. The expansion of the industry was largely a result of knowledge spillovers from the initial joint venture, because almost 90% of the workers trained by Daewoo left and started their own garment exporting firms. An important component of the knowledge provided by Daewoo was that it educated both local banks and government officials on how back-to-back letters of import credit could be used to avoid exchange controls in Bangladesh. The technology for shirt production was present in Bangladesh prior to the joint venture. The critical component for growth was the knowledge on how to market and finance these goods for export to the rest of the world. Furthermore, this knowledge was potentially useful to other export sectors.

To capture the dynamic process, we develop a simple multisectoral framework of trade in which the evolution of exporting experience is an integral part of the economic environment. In the basic setup outlined in sections 2 and 3, we assume that labor is homogeneous and capital is a specific factor used in the import-competing sector. It is a specific-factors model for traditional export and import-competing sectors together with a Ricardian adjunct where production activities in the modern sector require not only labor but also export services.[3] We assume that the unit services requirement in the modern sector decreases as the experience in exporting increases and that this experience has the nature of a "public good" with knowledge accumulated by one modern export producer spilling over to other modern export production activities.[4] We show how trade liberalization can set off a dynamic evolution of comparative advantage in the presence of such positive externalities from service sector activities. Countries enter international production of labor-intensive goods, with exports shifting progressively towards more service-intensive goods over time as experience accumulates. The expanding modern sector will also squeeze out traditional export sectors.

Our transition process differs from the "big push" model of Murphy et al. (1989), in which rising incomes create a multiplier effect in the demand for nontraded goods. In our model, the increased growth has the features of a "big push," but international trade plays a critical role.[5] More specifically, to reconcile the conflicting evidence concerning the effect of openness on economic growth in cross-country studies, it has been suggested that openness is a threshold variable shifting an economy from one

equilibrium to another (cf. Papageorgiou, 2002).[6] This argument is best illustrated by Azariadis (1996, p. 464): "we can use measures of . . . openness to help explain the clustering of middle-income economies into high-growth and low-growth groups." Our paper highlights precisely the role of trade liberalization played in such an endogenous sorting process for middle-income developing economies (East Asia and Latin America).

Section 4 extends the basic model to distinguish between the factor inputs required in production and service activities. We examine the case in which service activities require physical and human capital inputs, while production activities require less skilled labor. This model allows us to explore the impact of the externalities in exporting on income distribution. We show that productivity enhancements in the export sector will raise the return of unskilled labor relative to capital when the country produces modern sector goods and traditional import-competing goods. However, the income distribution effects are altered if the economy ceases to produce traditional import-competing goods. In either case, learning moves the country into the production of more service-intensive goods over time.

Related Literature

The role of externalities from learning-by-doing has also been stressed by Stokey (1991) and Young (1991). Stokey highlighted uncompensated positive spillovers from learning. It is argued that if human capital is accumulated via learning by producing high-quality goods, free trade will slow such a process down in the South. Young utilizes a Ricardian model of trade, where more sophisticated goods have higher unit labor requirements but generate greater gains from learning-by-doing. As a result, international trade may actually harm growth when trade opportunities encourage resource reallocation toward less sophisticated sectors. Our model differs in that learning arises from exporting, so that the initial export of less sophisticated goods in the modern sector provides an entrée into international markets and allows the country to move up to more sophisticated goods requiring larger service inputs over time. As a consequence, we are able to show a positive growth effect of free trade within a simple general-equilibrium framework without relying on any complex learning formulation.

Two previous studies closely related to ours are Ishikawa (1992) and Wan (2002). In his important earlier contribution, Ishikawa (1992) has a model emphasizing the role of learning by extending Stokey (1991) to allow for an endogenous industrial composition, to which our paper is similar. In addition to trade services, Ishikawa's model has two production sectors (agriculture and manufacturing), while ours has three—namely, traditional, import-competing, and modern export sectors. The separation of import-competing and modern export sectors in our setup is crucial for understanding the very different trade and growth experiences in East Asia versus Latin America as elaborated above. Moreover, in contrast with his work, we allow for both knowledge and human capital to be included in the general capital stock in the model presented in section 4. As a consequence, we can differentiate between the skilled and unskilled labor to characterize not only functional income distribution but also the skill premium. Particularly, we show that it is possible to have both skilled and unskilled wages increasing over time in the process of economic takeoff and aftermath growth. In an independent work, Wan (2002) provides an example illustrating that learning (in quality control and production scheduling) may reduce production cost and enable a shift towards heavy industry. In contrast, our paper formalizes in a dynamic general-

equilibrium framework the experiences from exporting, the evolution of knowledge accumulation, and the evolution of industrialization.

2. The Model

We consider a small open economy that has the potential to produce N goods using fixed endowments of labor (L), land (T), and capital (K). Good 1, set as the *numéraire*, is the traditional export good. The traditional good can be thought of as an agricultural or mineral product that is produced using labor and sector-specific land under conditions of perfect competition. Denote the sector 1 production function by $F(L_1, T)$, where F is assumed to be homogeneous of degree 1. Good 2 is the import-competing good, which is produced using labor and (sector-specific) capital according to the constant-returns-to-scale production function, $G(L_2, K)$. Let p_2^* denote the *world price* of good 2 and τ the *ad valorem* tariff, so the domestic price will be $p_2 = p_2^*(1 + \tau)$. Goods 1 and 2 are consumed domestically, with preferences described by $U(D_1, D_2)$, where D_i denotes the consumption of good i. The production technology of the traditional sector of the economy is thus characterized by the specific factor model, with capital and land being sector-specific factors and labor the mobile factor. Absent any other production activities, the tariff protects sector-specific capital in the import-competing sector.

Goods 3 to N are modern export goods which are not consumed domestically but can be exported to the world market at prices p_3 to p_N, respectively. For example, these goods may represent labor-intensive intermediate goods that are outsourced by firms in developed countries. Since the local economy may lack the technology required to produce other inputs in the chain of production required to produce the final good, there will be no local demand for these intermediate inputs in the absence of international trade. It will be assumed that these modern sector goods are *produced* under constant returns to scale using only labor, where the unit labor requirement for these goods is denoted by a_{Li} ($i = 3, \ldots, N$). However, exporting such modern sector goods requires not only production but service activities, which may include management and marketing as discussed in Jones and Kierzkowski (1990). In this section's basic model we assume that service activities make use only of labor as an input, but the quantity of necessary labor per unit of output tends to diminish as experience in establishing foreign contacts and obtaining knowledge of foreign distribution channels is acquired.

We formalize the role of services in the modern sector by writing the service requirement per unit of exports as $a_{Li}^s = a_{Si}b(Z)$, where $1/b(Z)$ is the productivity of a worker in the service sector and Z is an index of *experience* in exporting commodities in the modern sector. Our assumption is that the knowledge accumulated from export experience in the service sector is a public good that is applicable to all modern sector goods, so $b(Z)$ is the same for all modern sector goods. The knowledge accumulated from exporting is assumed to be exhausted at some finite level of experience, denoted $\overline{Z}$, with a_{Si} denoting the unit labor requirement for good i when the learning has been exhausted. More formally put, we assume

$$b'(Z) < 0, \text{ for } Z < \overline{Z}; \quad \text{with } b(0) > 1 \text{ and } b(Z) = 1 \text{ for } Z \geq \overline{Z}.$$

The public-good nature of the experience not only assures that knowledge accumulated in one modern export sector spills over to other modern export sectors, but also implies that these modern export sectors exhibit increasing returns as a result of uncompensated knowledge spillovers.[7]

With these assumptions on labor input requirements, the competitive profit condition for good i can be expressed as

$$w[a_{Li} + a_{Si}b(Z)] \geq p_i \quad \text{for} \quad i = 3, \ldots, N. \tag{1}$$

For given world prices, it is useful to define the wage rate that is attained if modern sector good i is produced for export:

$$\omega_i(Z) \equiv \frac{p_i}{a_{Li} + a_{Si}b(z)}. \tag{2}$$

At a given level of Z, the most profitable modern sector good will be the one for which $\omega_i(Z)$ is largest. Increased experience in exporting of good i reduces the labor requirement in the service activity, and hence will raise the wage that can be earned from exporting any of the modern sector goods. Under our specification of unit labor requirements, the ranking of goods by share of service costs is independent of the level of knowledge, so we can choose our numbering of modern sector goods from 3 to N such that they are arranged in ascending order of relative service intensities, a_{Si}/a_{Li}. Does this imply that each of these commodities will be produced in order? Not necessarily. For example, the world price of good 6 might be so low relative to costs as to preclude its adoption. However, suppose that at some level of Z, commodities i and j exhibit the same breakeven wage rate: $\omega_i = \omega_j$. If $j > i$, the ascendancy of service shares assures that $d\omega_j/dZ$ exceeds $d\omega_i/dZ$. That is, for higher values of Z, commodity j would yield a higher wage rate in a competitive equilibrium than does commodity i.[8]

The relationship between experience and the choice of most profitable modern sector good is illustrated in Figure 1, which exhibits the wage profiles for commodities 3, 4, and 5. For each sector, wage growth disappears as Z tends to $\overline{Z}$. The heavy upper envelope, $\tilde{\omega}(Z)$, is the wage that can be earned in the most profitable modern sector good for these three commodities. Thus, employment in the modern sector would move progressively from goods 3 to 5 as knowledge accumulates. The level of the ultimate modern sector wage, $\tilde{\omega}(\overline{Z})$, will depend on the degree of cost reduction due to service sector learning and the service intensity of modern sector goods. More generally, we can summarize the employment opportunities available in the modern sector by

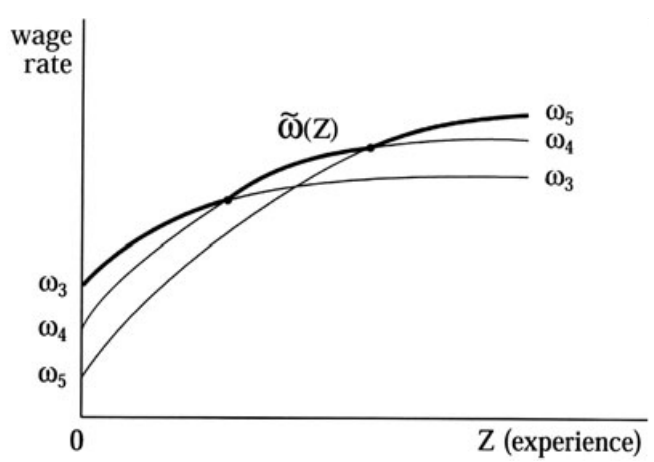

Figure 1. The Wage Schedule, $\tilde{\omega}(Z)$

$$\tilde{\omega}(Z) = \max_i \omega_i(Z), \quad \tilde{i}(Z) = \max j \in \text{argmax}\, \tilde{\omega}(Z). \tag{3}$$

Since commodities are indexed in ascending order of service intensities, and discarding sectors not profitable at any $Z \in [0, \overline{Z}]$, $\tilde{i}(Z)$ is upper semicontinuous and nondecreasing.

3. Equilibrium

Define $X_{\tilde{i}(Z)}$ as the output of commodity $\tilde{i}(Z)$ produced in the modern export sector. Then the labor market equilibrium, given export experience Z, can be expressed as

$$L_1 + L_2 + [a_{L\tilde{i}(Z)} + a_{S\tilde{i}(Z)} b(Z)] X_{\tilde{i}(Z)} = L. \tag{4}$$

Point E in Figure 2 illustrates the labor market equilibrium for $Z = 0$ in the case in which no activity in the modern sector is competitive. The marginal product of labor in sector 1, $F_L(L_1, T)$, is measured from right to left, and that in sector 2, $(1 + \tau)p_2^* G_L(L_2, K)$, is the curve from left to right. Given the initial factor endowments and the tariff rate, the equilibrium wage obtained when all labor is employed in sectors 1 and 2 exceeds the wage attainable in the modern sector, $\tilde{\omega}(0)$.

The lower curve $(p_2^* G_L)$ shows the labor demand schedule from the import-competing sector 2 after the tariff is eliminated as a consequence of trade liberalization. Would the intersection of this curve with the F_L schedule at E′ represent the new equilibrium? No. At the wage rate represented by E′, some activities in the modern sector become competitive, and their demand for labor must be added to the market. As a consequence the wage will settle at a value given by $\tilde{\omega}(0)$. The horizontal gap between the $(p_2^* G_L)$ schedule and the F_L schedule at this wage rate represents labor engaged in the modern sector. As in Figure 1, such labor is all devoted to industry 3 until experience accumulates with time. The liberalization-induced lowering of the wage rate hurts the return to capital (but raises land rents).

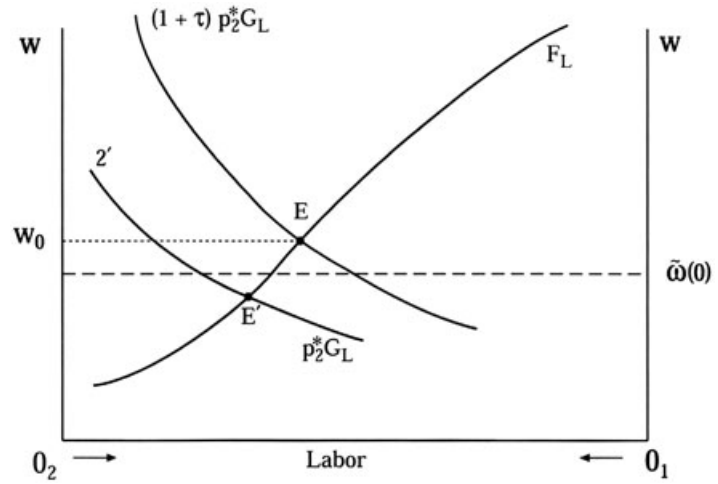

Figure 2. Labor Market Equilibrium

Transitional Gains from Trade

We now turn to the dynamics that arise as a result of the opening of production in the modern sector. We define the accumulation of export experience as simply the accumulation of past modern sector export experience to be

$$\dot{Z}(t) = a_{S\tilde{i}(Z(t))} X_{\tilde{i}(Z(t))}. \tag{5}$$

Two characteristics of (5) should be noted. First, we assume that experience exporting the traditional good does not generate the contacts and market information that are valuable in modern sector exports. Second, we assume that experience is proportional to the use of service sector labor, rather than to output of modern sector goods. Thus, knowledge accumulates more rapidly from more service-intensive goods.

If we consider an initial equilibrium in which the modern sector is in operation, the equilibrium employment levels in sectors 1 and 2 are given by

$$\begin{aligned} F_L(L_1, T) &= \tilde{\omega}(Z), \\ p_2 G_L(L_2, K) &= \tilde{\omega}(Z). \end{aligned} \tag{6}$$

Equations (6) can be inverted to yield employment levels for the traditional sectors, $L_i(Z)$ for $i = 1, 2$. The employment in the modern sector is derived from (4) to be

$$X_{\tilde{i}(Z(t))}(t) = \frac{L - L_1(Z(t)) - L_2(Z(t))}{a_{L\tilde{i}(Z(t))} + a_{S\tilde{i}(Z(t))} b(Z(t))}. \tag{7}$$

Increased experience in the exporting sector will raise the return available in the modern sector, which results in greater employment in the modern sector. Furthermore, it raises the productivity of labor in the service activity, so $X_{\tilde{i}(Z)}$ will be increasing in Z. Relabeling from equation (5) yields $\dot{Z}(t) = \Psi(Z(t))$, where $\Psi(Z) = a_{S\tilde{i}(Z)} X_{\tilde{i}(Z)}$. Since $\tilde{i}(Z)$ is nondecreasing in Z, $a_{L\tilde{i}(Z(t))}/a_{S\tilde{i}(Z(t))}$ must be nonincreasing in Z. Moreover, L_1, L_2, and b are all nonincreasing in Z. From (7), it is clear that Ψ is nondecreasing in Z, implying that the level of experience must be increasing over time until it reaches the upper bound, $\overline{Z}$.

In this dynamic process, the evolution of the export sectors can be illustrated by Figures 1 and 2. The accumulation of knowledge over time will raise the wage rate available in the export sector, and will cause production to shift into more service-intensive goods. The growth in earning opportunities in the export sector will also draw additional labor from other sectors of the economy, with this process proceeding until the learning economies are exhausted at $\overline{Z}$. The innovation here is that the liberalization will set off dynamic adjustments in sectors 3 to N, since the accumulation of exporting experience will cause $\tilde{\omega}(Z)$ to increase over time. This generates the dynamic gains from trade liberalization as knowledge in the service sector is accumulated. It will also result in a shrinkage in both the traditional export sector and the import-competing sector in response to the rising productivity in the new export sectors. This process will continue until experience reaches $\overline{Z}$ at which point a new steady state is reached.

Note that some of the initial income distributional effects of trade liberalization can be reversed during this process. Capital owners in the import-competing sector will unambiguously lose, because the rising labor productivity in the modern sector further reduces their return. The effect of trade liberalization on landowners and labor is

ambiguous. The initial reduction in the wage rate from trade liberalization benefits landowners and hurts labor. However, the export boom in the modern sector raises wage rates and squeezes the traditional export sector, which reduces the return to land.

Despite its simplicity, our model captures some important elements of globalization. In particular, trade liberalization kicks off a process in which resources move from traditional exports into new goods (modern exports) that were not profitable before liberalization. The accumulation of knowledge in the service sector causes an increase in the growth rate (relative to the zero growth rate of the otherwise static model), yet this effect eventually goes away. Moreover, knowledge accumulated in one export sector spills over to other export sectors, which results in an evolving pattern of exports, moving toward more service-intensive sectors.

The welfare consequences of trade liberalization can be understood by isolating three underlying channels, each of which leads to an increase in welfare. The first channel is the traditional welfare gain from trade liberalization in a small open economy with no factor or goods market distortions, holding the set of goods being produced fixed (i.e. no modern sector). The second channel is that the entry of production of the modern sector goods (for $Z = 0$) at free trade will raise welfare, since the potential to produce more goods must raise welfare at free trade in the absence of distortions. The final channel is due to the accumulation of experience in the modern sector, which must also be welfare-improving in the absence of distortions because it raises national productivity. The fact that trade liberalization will unambiguously raise welfare results from the fact that, under our specification, trade will raise the production of goods in which there are spillovers from learning.

At free trade, national welfare will be increasing in the level of national income. The growth rate of national income under free trade with production in the modern sector will be given by $\dot{Y}/Y = (\tilde{\omega}(Z)L_{\tilde{i}}/Y)(\tilde{\omega}(Z)^{-1}d\omega_{\tilde{i}}/dZ)\mathbf{\Psi}(Z)$.[9] This expression can be used to illustrate how the growth rate changes over time following the takeoff period. Both the first and third terms will be increasing in Z, since the share of modern sector income in total income and the amount of knowledge accumulation are increasing over time. These components represent a form of increasing returns that generates a growth rate that rises over time. This is offset by the growth rate of the wage rate, which is affected by the diminishing returns to knowledge accumulation ($d\omega_{\tilde{i}}(Z)/dZ \to 0$ as $Z \to \overline{Z}$) as illustrated in Figure 1. If the modern sector is initially quite small (i.e. $L_{\tilde{i}(0)} \approx 0$), we will get a hump-shaped relationship between the growth rate and time. The growth rate will initially increase due to the increasing returns in knowledge accumulation, but will eventually decline as the externalities from knowledge accumulation disappear.[10]

Determinants of Takeoff

The takeoff in the modern export sector considered here is driven by the fall in the wage rate for labor that can be used to produce goods for export. Entry into these sectors is less likely to occur in economies where wage rates are initially high. The previous discussion has emphasized the role of tariff protection in raising the wage rate sufficiently that the modern sector is not competitive. This model also suggests another route. Economies that are rich in specific factors used in traditional exporting and import-competing sectors will have high wages, and as a result the modern sector may not be competitive on world markets. This will in turn make the takeoff process more difficult. Regarding the second question, it may be noted that growth ceases when the

benefit from experience vanishes. Thus, transitional growth is prolonged if increasing returns as a result of knowledge spillovers in modern export sectors are strong, if new technologies in producing modern exportables are easily accessible, and if new markets for selling modern exportables are abundant. This positive growth effect of free trade therefore contrasts with findings in conventional learning models developed by Stokey (1991) and Young (1991). Moreover, it also suggests that high tariffs designed to protect infant industries in import-competing sectors may inhibit this learning spillover process and thus harm long-term economic development. This may, at least partially, explain why "the emperor's new clothes are not made in Colombia" in the case study by Morawetz (1981).

The preceding arguments might explain why trade liberalization has a different effect in Latin America than in Japan and the newly industrialized economies (NIEs, Hong Kong, Korea, Singapore, and Taiwan). All of these latter rapidly growing economies are generally short of natural resources and agricultural land and many were not rich in internal funds four decades ago. Furthermore, these economies had less resistance to trade liberalization due to the absence of active labor unions, and they geared rapidly toward establishing a strong knowledge in international trade. As a consequence, they took off successfully in response to trade liberalization policies. Moreover, the period 1960–90 is full of improvements in networking, the arrival of easily accessible new technologies, and increases in demands for new goods. Therefore, the rapid growing experience in Japan and the NIEs over that period has been prolonged, and is often noted as a development miracle.

The role of factor abundance in determining the profitability of the modern sector suggests that human capital accumulation could also be the source of the takeoff. If labor requirements are measured in efficiency units, improvements in the quality of low-skill labor through education raise the productivity of labor and reduce the wage rate for an efficiency unit of labor. If the initial wage exceeds the wage at which the modern sector is competitive, improvements in the quality of labor could reduce the wage rate on an efficiency unit sufficiently that the modern sector becomes competitive.

4. Factor Proportions and Service Activity in the Modern Sector

The benchmark setting in the preceding section is a specific factors model for traditional export and import-competing sectors together with a Ricardian adjunct in which the labor force used in production activities in the modern sector is the same kind as the labor used in service activities in that sector. In this section the model is generalized by requiring the service activity in the modern sector as well as in the import-competing sector to utilize a form of capital interpreted broadly to include human, entrepreneurial, and knowledge capital as well as physical capital.[11] This capital is designated by "H" instead of "K." Both H and unskilled labor, L, are mobile between the modern exporting sector and the import-competing sector. If positive levels of production are undertaken in both of these sectors, the model is of the Gruen–Corden (1970) type, with one sector using land and unskilled labor, and the rest of the economy comprised of a Heckscher–Ohlin 2×2 "nugget" of a pair of sectors using mobile (unskilled) labor, and capital of type H.[12] In keeping with our assumption that the worldwide location of modern sector production is primarily reflective of the availability of cheap labor, we will usually assume that the modern sector uses labor more intensively than the import-competing sector.

Equilibrium Prior to Trade Liberalization

We retain the use of w to denote the unskilled wage rate and let v denote the return to capital (H). The competitive profit condition for production of the ith commodity in the modern sector becomes

$$a_{Li}w + a_{Si}b(Z)v \geq p_i, \quad i = 3, \ldots, N. \tag{8}$$

Figures 3–5 utilize unit-value isoquants and labor demand schedules to depict equilibrium positions at various stages of trade liberalization and growth.

The initial equilibrium before trade liberalization is depicted in Figure 3(a) by point A, where the unit-value isoquant (at given world prices) for the import-competing product 2 is tangent to a cost line. The slope of this cost line equals (minus) w/v, where the solution to the factor prices depends as in any specific-factors model on both commodity prices (given) as well as endowments of all three factors (also given). These

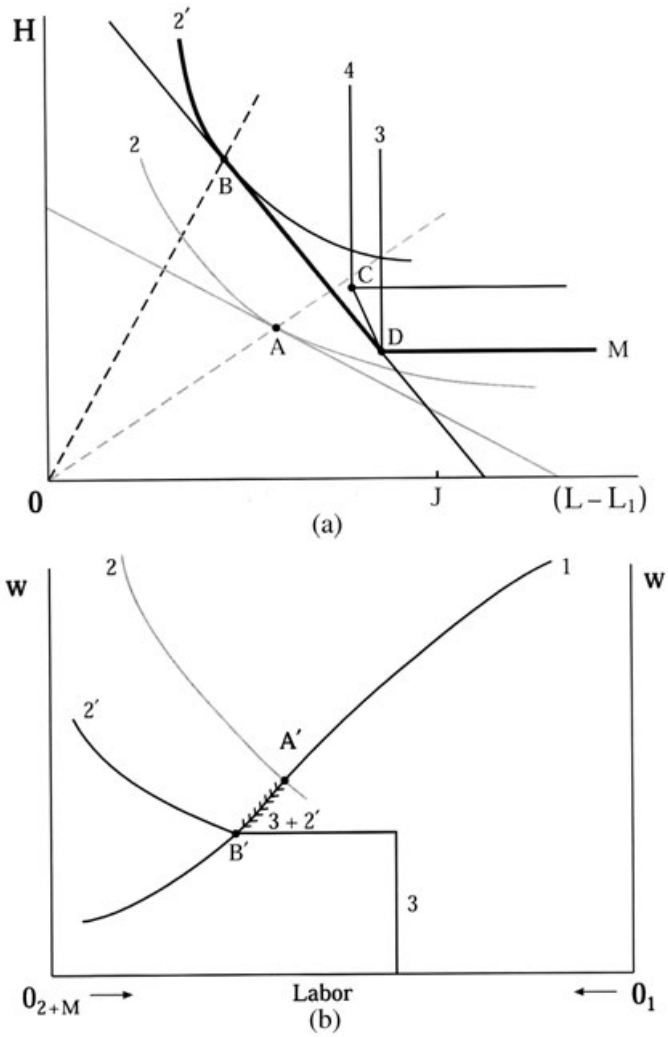

Figure 3. Trade Liberalization and Growth: Stage I

prices and endowments support the labor-demand schedules in Figure 3(b), similar to Figure 2 in the earlier model. The initial equilibrium for the traditional export sector (1) as well as for the import-competing sector (2) is shown by the intersection at point A′. Shown as well in Figure 3(a) is a pair of fixed-coefficient unit-value isoquants for the most labor intensive of the potential entrants in the modern (*M*) exporting sector. The word "potential" is relevant here since at the initial tariff levels neither of these modern activities is sustainable in the sense of equalities in equation (8).

This situation is altered in the case in which the tariff level on the import-competing product is lowered, as shown in Figure 3(a) by the outward radial movement of commodity 2's unit-value isoquant to position 2′. Since the domestic price, p_2, is given by $(1 + \tau)$ times the world price, p_2^*, a reduction in tariff rate, τ, induces this fall in p_2, which is assumed to be just sufficient to allow production of one of the commodities in the modern exporting sector—commodity 3. Denoting land rentals by r_T, the algebraic representation of the sequence of factor price changes induced by trade liberalization in this specific-factors setting is shown below:

$$\hat{v} < \hat{p}_2 < \hat{w} < 0 = \hat{p}_1 < \hat{r}_T. \tag{9}$$

The steeper budget line, BD, in Figure 3(a) confirms that the factor price ratio, w/v, has increased, although the wage rate has fallen relative to the fixed price of traditional exports, p_1 (fixed at unity). This latter decline is illustrated in Figure 3(b) by the move from A′ to B′, as sector 2's labor-demand schedule shifts down with freer trade. This allows an expansion in the output of traditional exports at the expense of production in the import-competing sector.

Two important loci in Figure 3(a) should be noted. The first, outlined by 4CDM, is the convex hull of the unit-value isoquants for the *modern export sector*, assuming this is comprised of only two commodities. We will refer to this as the composite unit-value isoquant for the modern sector, since it represents the combinations of L and H that would yield one unit of value from modern sector activities. This composite unit-value isoquant was above the unit cost line in the initial equilibrium at A before trade liberalization. The second, outlined in the heavy segment, 2′BDM, is the composite unit-value isoquant for the *nugget* consisting of all activities using unskilled labor and capital. As in the definition of the composite isoquant for the modern sector, this isoquant is the convex hull of isoquants in all activities using unskilled labor and capital. In Figure 3(b) the demand curve for labor emanating from the nugget is shown to consist of a downward-sloping portion (where only commodity 2 is produced in the nugget), a horizontal portion (where commodity 2 is joined by commodity 3), and a vertical portion (representing complete specialization in the third commodity, if the wage rate relative to the return to capital falls compared with the slope of line BD in Figure 3(a)).

Figures 4(a) and (b) carry on the story of trade liberalization, with a continuation of tariff reduction in the import-competing sector. Such a move allows, for the first time, active production for export in the modern manufacturing sector. As such production takes place, experience in exporting accumulates, and this will act like a public input and lower the input requirements for skilled labor and capital in both (all) industries in the modern M-sector. However, this is getting ahead of the story. Since experience takes time to accumulate, its reverberations on costs are put aside and in Figures 4(a) and (b) only the price effect of the further tariff reduction is considered. Thus the unit-value isoquant for the import-competing good is radially shifted outwards to curve 2″. The algebraic ranking on factor prices now follows the Heckscher–Ohlin pattern, (10):

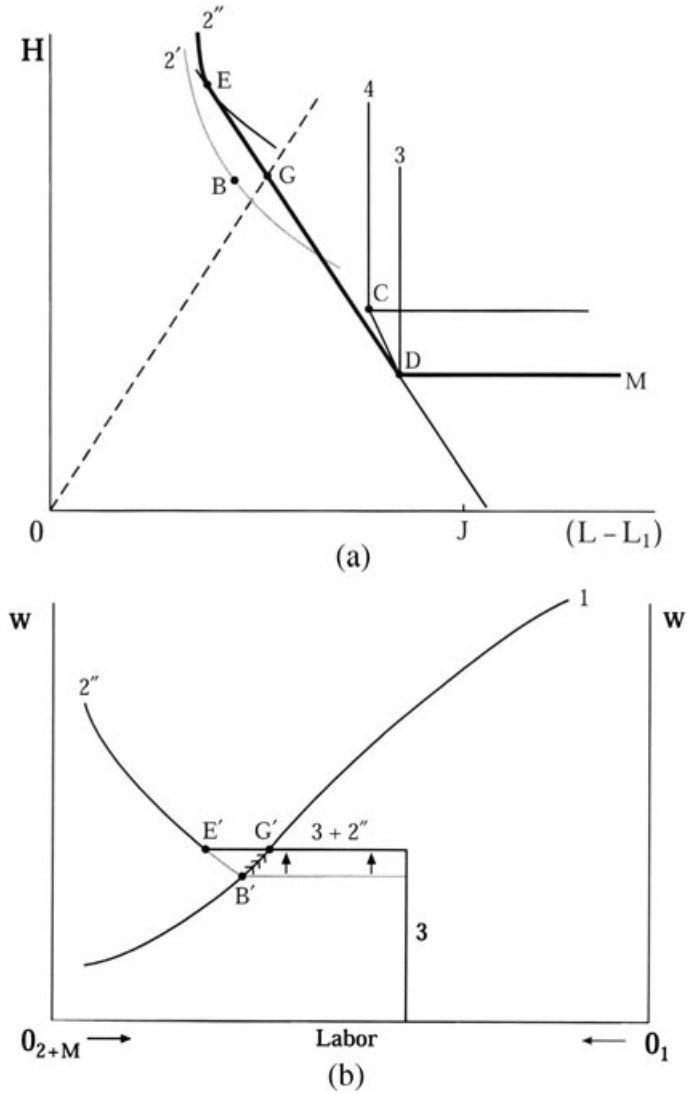

Figure 4. Trade Liberalization and Growth: Stage II

$$\hat{v} < \hat{p}_2 < 0 = \hat{p}_M\,(= \hat{p}_1) < \hat{w}. \tag{10}$$

With the import-competing sector being capital-intensive, its return, v, falls by a magnified amount and the wage rate actually rises. The increase in the w/v factor price ratio causes the import-competing sector to adopt more capital-intensive methods of production, the move from B to E in Figure 4(a). The ED portion of the composite unit-value isoquant for the nugget (2″EDM) is steeper than the BD section in Figure 3(a), and the increase in the wage rate relative to the fixed price of traditional exportables (p_1) is captured in Figure 4(b) by the upward shift of the horizontal stretch of the labor-demand curve of the nugget when sectors 2 and 3 are active in production. This corresponds to the rise of w from B′ to G′, with distance E′G′ indicating the amount of labor now being devoted to the modern exporting sector (all of it used to produce commodity 3).

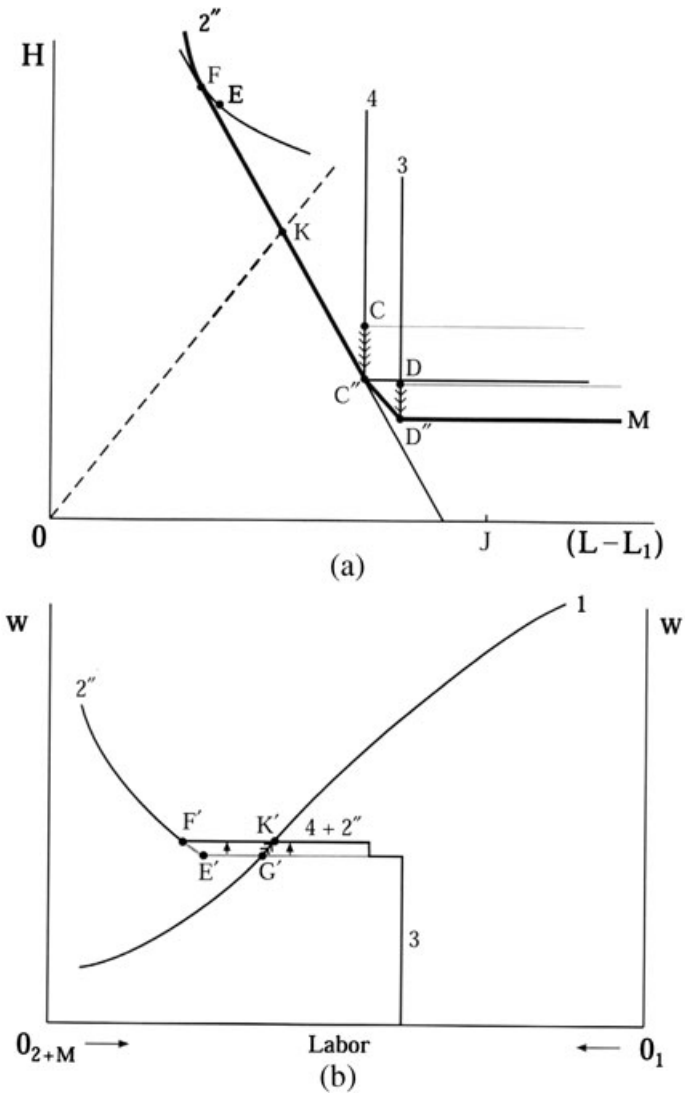

Figure 5. Trade Liberalization and Growth: Stage III

Growth of the Modern Sector

The onset of modern sector production will result in knowledge accumulation and dynamic adjustments because export experience raises the productivity of capital in the modern sector. We are assuming that the quantity of skilled labor and capital (the composite variable, *H*) required to export any commodity in the modern manufacturing sector is proportionally reduced. This is illustrated in Figure 5(a) by the fall of corner-point C to C″, proportional to that from point D to D″. (Points C, D, and J all lie on the same line in Figures 3(a), 4(a), and 5(a); points C″, D″, and J also lie on a straight line anchored at J.) The drop from C to C″, relatively of the same amount as that from D to D″, reflects the public-good nature of the increase in experience exporting from the modern sector. The new composite unit-value isoquant for the nugget making use of H and L is 2″FC″D″M. Note that in the modern exporting sector,

commodity 4 has replaced commodity 3, as a consequence of the increase in the wage/rental ratio. Such an increase follows from the fact that knowledge accumulation in the modern sector is akin to technological progress in the labor-intensive sector in the nugget. In Figure 5(b) this is illustrated in the move from G′ to K′, which causes labor to be reallocated from traditional export sector, 1, to the nugget (ray 0K in Figure 5(a) is flatter than ray 0G in Figure 4(a)).[13]

Our assumption that all industries in the modern manufacturing sector are more labor-intensive than the import-competing good is arbitrary. It was made to highlight the notion that the attractive aspect of such industries in the modern sector is their intensive use of unskilled labor, even though the learning economies are associated with the use of "capital." However, suppose that some industries in the modern sector are indeed more skilled-intensive than is commodity 2. In such a case these industries, once becoming viable and yielding cost reductions via experience in exporting, could cause industry 2 to shut down once its unit-value isoquant (at given domestic price, for example that in free trade) lies above the composite unit-value isoquant. The nugget consists only of modern sector commodities, and if experience in exporting results in further reductions in costs, the nominal wage rate would remain unaltered, with all gains accruing to the composite capital factor, *H*.

Further insights into the growth process can be obtained by changing our assumption of a finite number of potential export commodities in the modern sector in favor of the *continuum* assumption, leading to a smoothly bowed-in unit-value isoquant in the M-sector. And suppose the move to free trade has wiped out the original import-competing sector, so that once again the specific factors setting describes production: traditional exportables (1) employ land and unskilled labor while the single best commodity in the M-continuum makes use of composite capital and unskilled labor. If export experience is still shifting the M-isoquant proportionally downwards, we now show that systematically the favored industry in the M-sector becomes more and more H-intensive:

The labor-market clearing condition for this specific-factors framework is

$$a_{L1}X_1 + a_{LM}X_M = L. \tag{11}$$

In each sector the quantity of the specific factor is assumed given, so that any proportional expansion in output must be matched by a proportional reduction in the quantity of H or of K used *per unit output*. Denoting by λ_{Li} the fraction of labor allocated to the *i*th sector, total differentiation of the full-employment condition (11) for fixed endowments leads to

$$\lambda_{L1}(\hat{a}_{L1} - \hat{a}_{T1}) + \lambda_{LM}(\hat{a}_{LM} - \hat{a}_{HM}) = 0. \tag{12}$$

The elasticity of demand for labor in the first industry, call it γ_{L1}, relates $(\hat{a}_{L1} - \hat{a}_{T1})$ to the change in the wage rate. In the M-sector things are a bit more complicated because of the reduction in a_{HM} as experience in exporting is accumulated. For a given wage rate this is captured by the term $\hat{b}$, so that $(\hat{a}_{LM} - \hat{a}_{HM})$ equals $-\gamma_{LM}\hat{w} - \hat{b}$, where γ_{LM} is the elasticity of demand for labor in the M-sector. Substitution into the labor-market clearing equation of change yields

$$\hat{w} = (\lambda_{LM}/\gamma_L)(-\hat{b}), \tag{13}$$

where $\gamma_L \equiv \lambda_{L1}\gamma_{L1} + \lambda_{LM}\gamma_{LM}$ is the elasticity of demand for labor overall. Recall that in Figures 3(a)–5(a) the rays from the origin 0B, 0G, and 0K, rotated clockwise because the amount of labor required in the traditional export sector kept being reduced with

increases in the wage rate. The slope of these rays is $H/(L - L_1)$, so that the relative reduction in the slope is shown by $-(\lambda_{L1}/\gamma_{LM})\hat{L}_1$, or, by $-(\lambda_{L1}\gamma_{L1}/\lambda_{LM})\hat{w}$, or, equivalently, $-(\lambda_{L1}\gamma_{L1}/\gamma_L)(-\hat{b})$, which is a fraction of the reduction in the coefficient, a_{HM}. That is, the ray from the origin indicating factor proportions does not fall proportionally as much as does the coefficient of a single industry in the M-continuum. Thus as the wage rate rises with experience, a switch is made towards more and more H-intensive industries.

What can be said about other factor returns? Differentiating the competitive profit conditions for the M-sector, and letting θ_{hi} represent factor h's distributive share in the ith sector ($h = L, H$ and $i = 1, 2$), yields

$$\theta_{LM}\hat{w} + \theta_{HM}\hat{v} = \theta_{HM}(-\hat{b}), \tag{14}$$

so that, solving for the relative change in the return to composite capital, we have

$$\hat{v} = \left\{1 - \left(\frac{\theta_{LM}}{\theta_{HM}}\right)\left(\frac{\lambda_{LM}}{\gamma_L}\right)\right\}(-\hat{b}). \tag{15}$$

Thus the return to composite capital could rise as well during this process as long as the elasticity of demand for labor overall, γ_L, is sufficiently high so that the wage rate does not increase very much.

Of course two caveats need to be mentioned. The first refers back to the case in which the import-competing sector is wiped out and, in the case of finite numbers of commodities instead of a continuum, two modern exportables make up the nugget. In this case cost reductions from accumulating experience redound all to the credit of composite capital, with the wage rate held constant. The second caveat is that the gains from experience may run out. As for land rentals, if the price of traditional exportables is kept constant throughout this process, land rents rise initially with tariff reduction until the modern sector becomes active; but once it does, increases in the nominal wage rate cause land rentals to fall.

5. Concluding Remarks

We have provided a simple illustration of how trade can play an important role in promoting takeoff and growth. There may be a number of productive activities that a country could exploit for export, even in the absence of domestic markets, if only the wage rate were low enough to make locally produced commodities competitive on world markets. Here we have assumed that it is protection that has been provided to import-competing commodities that leads to a high local wage rate, so that it is trade liberalization that initially lowers wage rates and allows fresh exports from industries in which there is accumulation of knowledge about how to export goods, knowledge that is like a public input to other emerging export activities in the modern sector. Not considered explicitly, but nonetheless a possibility that is realistic in some developing countries, is the existence of natural resources such as gold or oil that tend to support high local wage rates. These, in turn, may prevent the emergence of a modern manufacturing sector. It is not tariff protection, but rather the working out of the law of comparative advantage, that is the stumbling block. Such a possibility highlights the notion that some export activities, for example, of natural resources, afford little possibility of new learning opportunities. By contrast, it is the development of new manufacturing activities that require service sector inputs in order that goods locally produced can successfully invade world markets that open up the prospect that learning spillovers can promote exports in other activities as well. During this process,

growth rates can become positive and wage rates rise until a return to more steady states is reached as new learning comes gradually to a halt.

We have pursued two different routes in exploring the takeoffs possible with trade liberalization. In the first of these the specific-factors model was exploited—a traditional export sector using land and labor was initially coexistent with an import-competing sector using capital and labor. In the wings was a set of potential manufacturing activities requiring increasing degrees of service inputs, although these required only the same kind of labor used in the other two sectors. The second route was more realistic and led to a richer set of factor price dynamics. The potential manufactured exports in the modern sector required not only labor but also a general form of "capital" that was a composite of human, entrepreneurial, and physical capital. The import-competing sector, originally protected, used this pair of factors as well, although the potential new entrants were generally more labor-intensive. Once again, the removal of protective barriers forced an initial wage reduction that allowed the new export activities to attain a foothold in world markets and, during the process, knowledge of how to export spilled over to help reduce costs and allow more service-intensive manufactures to be established and wage rates to rise.

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Notes

1. For a discussion of the definition of an economic takeoff and a formal growth model of such a process, the reader is referred to Rostow (1960) and Tsiang (1964), respectively.

2. Although the effective protective rates are still higher than Japan (about 30%) and the US (about 20%) during that period, they are much lower than the comparable figures in Argentina (160%) and Brazil (120%). Trade liberalization policy and the consequent export promotion have been emphasized by Adelman (1999) to lead Korea and Taiwan to rapid growth, whereas

the overly protective import substitution in Colombia has been argued by Morawetz (1981) to inhibit its long-run competitiveness in international markets.

3. For a comprehensive discussion of the role of services in production and trade, the reader is referred to Jones and Kierzkowski (1990).

4. The evidence from firm-level data finds little productivity effect of export learning but a strong productivity effect of self-selection of entry (for example, see Bernard and Jensen, 1999, and papers cited therein). It should be noted that this evidence is not inconsistent with our assumptions on export learning, since learning in our model is a public good and would not necessarily create a differential productivity effect for different firms. This empirical literature only rules out the significance of firm-specific learning from exporting. Furthermore, our treatment of exporting firms as producing products for the world market that are different from those being consumed domestically is consistent with the evidence that exporting firms are different from those that do not export.

5. Matsuyama (1991) and Chen and Shimomura (1998) examine models in which the presence of external economies leads to multiple equilibria. They show that a big push may enable a country to move from a low- to a high-growth equilibrium. While the equilibrium selection in Murphy, Shleifer and Vishny is history-dependent, self-fulfilling prophecies play important roles in Matsuyama and in Chen and Shimomura. Findlay and Jones (2001) point out that this big-push literature largely ignores any essential role of trade played in the process of economic takeoffs.

6. While Edwards (1998) and Frankel and Romer (1999) find a positive growth effect of openness, Rodriguez and Rodrik (2000) document some skepticism about such causation. By allowing economic regimes to be selected by the data, Papageorgiou (2002) shows the presence of such a threshold effect of openness in a cross-section of 96 countries.

7. Our way to model the export experience as a public good is made for convenience. Alternatively, one may consider Marshallian externality in knowledge capital, human capital, and raw labor as in Romer (1986), Lucas (1988), and Matsuyama (1991), respectively.

8. Differentiating (2) with respect to Z yields the elasticity of the ω_i with respect to experience to be $-\theta_{Si}(Z)[b'(Z)/b(Z)]Z$, where $\theta_{Si}(Z) = a_{Si}b(Z)/[a_{Li} + a_{Si}b(Z)]$ is the share services in total costs in sector i. This result establishes that, for $j > 1$, $\tilde{\omega}_j$ must be steeper than $\tilde{\omega}_i$ if the two schedules intersect. A necessary condition for each good to be produced at some Z is that p_i/a_{Li} be increasing in i. Since $\omega_i = (p_i/a_{Li})[1 - \theta_{Si}(Z)]$, a good would never be produced if it had a lower value of p_i/a_{Li} than a less service intensive good.

9. Factor income can be expressed as $Y(Z) = w(Z)L + r_T(Z)T + r_K(Z)K$. At free trade, the change in national income over time will coincide with the change in factor income, $dY/dZ = Ldw/dZ + Tdr_T/dZ + Kdr_KdZ$. The zero-profit conditions from sectors 1 and 2 yield $L_1(dw/dZ) + T(dr_t/dZ) = 0$ and $L_2(dw/dZ) + K(dr_K/dZ) = 0$. Utilizing these results in the change in factor income and assuming that we are on an interior point where the specialization in the modern sector is constant, we obtain $dY/dZ = L_{\bar{i}}d\omega_{\bar{i}}/dZ > 0$. The equation in the text is obtained using $\dot{Z} = \Psi(Z)$ as defined following (7).

10. Thus, our framework does not allow for sustained growth. Those interested in trade and endogenous growth are referred to Ventura (1997) and Bond et al. (2003), and papers cited therein.

11. It is likely that the marketing and financial services required to sell the goods on world markets will require a higher level of human and entrepreneurial capital than does the production of goods for the world market (see Jones et al. (1999), where the human capital services in exporting represent one of the "three faces of factor intensities"). We do not permit international mobility of skilled alien labor to complement local workers. Those interested in such a possibility are referred to Jones and Marjit (1995).

12. An alternative outcome of trade liberalization would have production in the import-competing sector wiped out, leaving either a specific-factors outcome (traditional exports and a single entry in the modern export sector) or a variation in the Gruen–Corden scenario where the "nugget" consists of a pair of modern exporting activities. The behavior of wages during the takeoff period would depend on which outcome develops. In Jones and Marjit (1992) there is a

discussion in which the production framework emerging, whether of a specific-factors model or a Gruen–Corden model, depends endogenously on prices and factor endowments. We discuss this possibility in more detail later.

13. In going from Figure 4(a) to Figure 5(a) we have noted that the production of commodity 3 is wiped out, to be replaced by production of commodity 4. For some smaller price drop for import-competing commodity 2, both commodities 3 and 4 could be producible. In that case could the import-competing commodity 2 vanish, to be replaced by commodities 3 and 4 in the modern sector? No, since the ratio of factors available in the nugget, $H/(L - L_1)$, could not be accommodated by a convex combination of 3 and 4. Both the ray 0G in Figure 4(a) and 0K in Figure 5(a) are steeper even than the factor ratio employed in commodity 4. Later we discuss a case in which the import-competing sector is wiped out.