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# 4            The Factor Proportions               Explanation of Trade,               Distortions, and Employment

At the outset of the project it was readily apparent that existing formulations of the factor proportions explanation of trade, or Heckscher-Ohlin-Samuelson (HOS) model, would not serve as a satisfactory analytical basis for the project. As generally stated, the HOS model was cast in a framework based on two commodities, two countries, and two factors of production.

It is straightforward, however, to extend this framework meaningfully to take into account the realities of agricultural and industrial sectors in developing countries. That framework is set forth in section 4.1. A second task was to analyze the ways domestic factor market interventions might affect observed patterns of trade and associated factor utilization. The theory underlying that relationship is set forth in section 4.2.

## **4.1 The HOS Model with Many Goods**

The basic question explored in this section is how the HOS model can be set forth in a meaningful way to provide testable hypotheses about the relationship between trade strategies and employment in developing countries. Three strands of thought are central to the argument: (1) It has long been recognized that developing economies have large agricultural

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sectors and that trade in primary commodities cannot be explained by the countries' endowment of labor and capital. (2) Given the observed difference in factor endowments between developing countries and the industrialized world, it seems reasonable to develop a model of complete specialization rather than one of factor price equalization. (3) While numerous theoretical reasons have been advanced in attempts to explain the Leontief (1953) paradox—that American exports were more labor-using than American import competing production—the effects of distortions in goods and factor markets have not been systematically explored in the context of empirical testing of the Heckscher-Ohlin-Samuelson (HOS) factor proportions explanation of trade. While such an omission may be acceptable in dealing with some developed countries, it is surely not so for the developing countries, where market imperfections are thought to be the rule rather than the exception.

First, a simple model of comparative advantage is developed for  $n$  commodities,  $m$  countries, and two factors of production, under the usual competitive assumptions. Next, that model is amended to incorporate the existence of a primary commodity or agricultural sector. The implications of the analysis for empirical work will then be examined. In section 4.2 distortions in the goods and factor markets are introduced into the model, and consideration is devoted to the way they would alter the observed pattern of trade and factor proportions employed in export and import-competing industries, with particular attention to methods of identifying the effect of those distortions upon the patterns that would otherwise emerge.

Two issues arise in connection with the hypotheses emanating from the HOS model. The first relates to the question whether predictions pertain to the pattern of production or the pattern of trade. For reasons that will become evident below, it proves useful to discuss patterns of production, although there is a close, logical link between production and trade patterns in the  $n$ -commodity model.

The second issue relates to alternative interpretations of the predictions arising from the model. On the one hand, they can be interpreted positively, as predictions about the actual pattern of production, in which case they would constitute a set of hypotheses about the observable production patterns. Alternatively, the factor proportions model can be interpreted normatively, as predictions about the properties of an efficient production pattern that will provide society with the largest attainable consumption bundle for any given inputs allocated to traded-goods production. The latter interpretation corresponds, up to a point, to a hypothesis about the nature of an efficient pattern of production. Predictions can then be interpreted as forecasting what would happen under efficient resource allocation.

The two alternative interpretations coincide, of course, if the structure of production is efficient, but they might not coincide under inefficient

allocations. Since one purpose of the project is to consider the effect of market distortions on the observed pattern of trade, it is useful to regard the HOS model and hypotheses as normative. Under this second interpretation, as will be demonstrated, the HOS hypotheses could be correct, while observed production patterns ran counter to them owing to inefficient production patterns. Although the model developed in this chapter assumes a well-functioning competitive market, it can readily be shown that the HOS hypotheses would also be borne out given the assumptions about technology under any economic structure that provided an efficient allocation of resources for production of tradable goods.

#### 4.1.1 The Factor Proportions Model

##### 4.1.1.1 *Assumptions and Statement of the Basic Model*

There are assumed to be  $n$  commodities,  $m$  countries, and two factors of production in the basic model considered here. Later the model will be extended to incorporate an agricultural sector, and the  $n$  industries under consideration here will then be understood to be those producing  $n$  separate commodities within the manufacturing sector. For the moment, however, it is simplest to start by regarding the  $n$  commodities, each produced with two factors of production, as constituting the entire economy. Each of the  $n$  production functions displays constant returns to scale, with diminishing marginal product to each factor of production.

Consider now the cost-minimizing labor/capital ratio associated in each industry with a particular arbitrarily chosen wage/rental ratio. Order the commodities so that commodity 1 has the highest labor/capital ratio (at that wage/rental ratio), commodity 2 has the next highest, and so on down to commodity  $n$ , which has the lowest labor/capital ratio. It will be assumed that, for all wage/rental ratios, repetition of this procedure would result in exactly the same ordering of commodities; that is, there are assumed to be no factor intensity reversals. A sufficient condition for this ordering of commodities to be the same throughout the entire range of wage/rental variation is that all production functions have the same elasticity of substitution. The exclusion of factor intensity reversals implies something fairly important: with undistorted factor markets, one would observe the same ordering of factor intensities across industries in every country, regardless of whether or not goods prices were the same. This proposition will be seen below to be of some importance for testing for the effects of factor market distortions.<sup>1</sup>

We now have a labor intensity ordering of production functions across countries and a specification of technology that is common to all  $m$  countries. In addition, it is assumed that within each country perfect competition prevails in every industry in which there are positive production levels, with perfect factor mobility among all producing industries.

The wage rate equals the value of the marginal product of labor, and the rental on capital equals the value of the marginal product of capital for all industries with positive production levels. These assumptions ensure that each country will be producing efficiently on the boundary of its production-possibility set and that the domestic marginal rate of transformation between any pair of produced commodities will equal the price ratio.

These specifications of the nature of the market within each country, and of the production technology, are the same for all countries. What distinguishes each country is its labor/capital endowment. For purposes of simplicity, it is assumed that each country has its own fixed and inelastic supply of labor and of capital. Full employment of both factors prevails in every country. On that basis, one can compute the ratio of the labor to the capital endowment in each country. The countries can then be so numbered that country 1 has the highest endowment of labor to capital, country 2 the next highest, and so on to country  $m$ , which has the lowest labor/capital endowment. Thus, commodities are numbered so that a higher number implies a higher capital/labor ratio in production; countries are numbered so that a higher number is associated with a greater abundance of capital relative to labor.

The assumptions made so far are sufficient that, for any given set of prices confronting producers in a particular country, the area along the boundary of the production-possibility set in which competitive equilibrium can occur will be fairly closely circumscribed. For a particular country and set of prices, there are three possibilities. First, it is possible that it will be profitable to produce only one commodity, in which case all labor and capital within the country will be employed in that industry, the wage/rental ratio being determined by the production function for that industry. Second, it may be profitable to produce exactly two commodities, in which case the wage/rental ratio will be determined by the price ratio between the two goods and the precise composition of output will be such that factors are fully employed at the factor proportions implied by the wage/rental ratio. Third, it may be that it is equally profitable to produce three or more commodities, in which case the precise composition of output is indeterminate, although the wage/rental ratio will be determined by the prices of any two of the commodities.<sup>2</sup>

So far, the production side of the model has been specified. To develop a full general-equilibrium model of trade, it would be necessary to add some demand relations to the model and then to establish some properties of the resulting equilibrium price, production, and trade constellation. In exploring the implications of the HOS model, however, it can be assumed that international prices are given. Hypotheses can then be formulated in terms of the structure of production (and later transformed into hypotheses about the factor intensity of trade). As is well known, the only way demand patterns may influence the HOS predictions is through

the possibility that they might offset differences in production patterns. It will be seen below that the only role demand patterns can play in this  $n \times m \times 2$  model is to determine whether, when more than one commodity is produced by a particular country, produced commodities are exports or import-competing goods.

One way to interpret the assumption that international prices are determined outside the system is to assume that each country under consideration is small relative to the rest of the world and thus does not influence international prices by its production and consumption behavior. It is more satisfactory, however, simply to postulate that there is in the background a price-determining mechanism, via demand and supply relations, that results in the establishment of some constellation of equilibrium prices. The setting, then, is that international prices are given and there are no transport costs or other impediments to trade. Therefore prices are the same in all countries (since there can be no home goods in the absence of transport costs). The zero-transport-cost assumption will be relaxed below, and the implications of the HOS model for factor proportions in the presence of transport costs will be examined.

#### 4.1.2 Implications of the Basic Model

For any particular country, given international prices, either only one commodity is produced or the domestic wage/rental ratio is determined by the commodity/price ratio when two or more commodities are produced. For a pair of countries, the implications of this proposition are straightforward. If both countries produce two or more goods in common (or, at the limit, if producers in both countries are indifferent between their existing production pattern and an output bundle that would entail producing two or more goods in common), there will be a common wage/rental ratio between those two countries. All that can be said about production patterns is that factor proportions in each country will be the same in each industry (with the same wage/rental ratio) and the more labor-abundant country will have a production bundle more heavily weighted toward the labor-intensive commodities. It is possible that the more labor-abundant country might produce a commodity more capital intensive than some commodity produced by the capital-abundant country: as Bhagwati (1972) has shown, only the overall weighting of factor intensities can be predicted when factor rental equalization occurs.

For present purposes, let us assume that there is no factor rental equalization. This does no violence to the basic model: if two countries have overlapping production patterns and factor rental equalization, they can be regarded as one country in an economic sense. Such may be the case, for example, for some of the European Common Market countries.

In effect, the assumption of no equalization of factor rentals implies that no pair of countries produces two commodities (or more) in com-

mon; specialization must result.<sup>3</sup> What, then, can be said about the production patterns for two countries between which factor rentals are not equalized? It follows immediately that the more labor-abundant country will specialize in producing more labor-intensive (lower-numbered) commodities than the more capital-abundant country. The more labor-abundant of any pair of countries cannot produce any commodity more capital intensive than the least capital-using commodity produced in the other. The two countries might produce a commodity in common (if they are adjacent to each other in factor endowments), but the wage/rental ratio would be lower in the more labor-abundant country, and it would produce the common commodity using a more labor-intensive technique.

That the wage/rental ratio must be lower in the labor-abundant country follows immediately from the fact that, if the ratio were higher, it would be profitable to produce more capital-intensive goods with more capital-intensive techniques in the labor-abundant country, an impossibility under the assumption of full employment in both countries.

It is evident that the foregoing statements hold independently of the number of commodities under consideration. In a world of one hundred commodities and two countries, it would be quite possible for the more labor-abundant country to specialize in the first forty-nine commodities, while the other country produced 51 or 52.<sup>4</sup>

Figure 4.1 illustrates the possible sorts of production patterns that might emerge under the assumptions set forth above. In figure 4.1,  $m = 11$  and  $n = 9$ , although other numbers are equally plausible. Commodities are listed in the columns and countries in the rows. An X in the  $i$ th row and  $j$ th column indicates that the production of commodity  $j$  is positive in the  $i$ th country, and a blank means there is no production of the commodity in question. For expository convenience it is assumed that there are no cases with zero production levels where producers are indifferent to whether or not they produce.

Inspection of the combinations of production patterns between pairs of adjacent countries illustrates the properties of the model. Country 1 produces commodities 1 and 2 and produces commodity 2 in common with country 2. There is, however, no presumption of factor rental equalization between countries 1 and 2, since country 1 may have a considerably lower wage/rental ratio than country 2. Country 2 also produces commodities 3 and 4 (and must be endowed with a higher capital/labor ratio than country 1), producing commodity 4 in common with countries 3, 4, 5, and 6. It is apparent, however, that the capital intensity of production of commodity 4 is greater in each higher-numbered country. Note that country 2 produces one commodity in common with country 1 and one commodity in common with country 3: there is no factor rental equalization because there are not two commod-

|         |    | Commodity |   |   |   |   |   |   |   |   |
|---------|----|-----------|---|---|---|---|---|---|---|---|
|         |    | 1         | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Country | 1  | X         | X |   |   |   |   |   |   |   |
|         | 2  |           | X | X | X |   |   |   |   |   |
|         | 3  |           |   |   | X |   |   |   |   |   |
|         | 4  |           |   |   | X |   |   |   |   |   |
|         | 5  |           |   |   | X | X |   |   |   |   |
|         | 6  |           |   |   | X | X |   |   |   |   |
|         | 7  |           |   |   |   | X | X |   |   |   |
|         | 8  |           |   |   |   | X | O | X |   |   |
|         | 9  |           |   |   |   |   | X | X |   |   |
|         | 10 |           |   |   |   |   |   | X |   |   |
|         | 11 |           |   |   |   |   |   |   | X | X |

Fig. 4.1 Possible production patterns for eleven countries and nine commodities.



ities produced in common. Countries 5 and 6 produce two commodities in common and therefore must have equal wage/rental ratios. Likewise, countries 7, 8, and 9 must have factor rental equalization between them, although at a higher wage/rental ratio than countries 5 and 6. That country 8 does not produce commodity 6 illustrates the remote possibility of factor rental equalization in a circumstance where a more labor-abundant country (number 7) produces a more capital-intensive commodity (number 6) than a more capital-abundant country (number 8, which produces commodity 5).<sup>5</sup>

Country 10 also produces commodity 7 but uses more capital-intensive techniques than do the three countries with factor rental equalization. As drawn here, country 11 is the only country producing the two most capital-intensive commodities, 8 and 9, although it could happen that factor rental equalization took place among the most capital-abundant countries, with more than one country producing the most capital-intensive commodity.

Obviously, other constellations of production patterns are also possible, but figure 4.1 sufficiently illustrates the basic possibilities. Generalizing, when there is no factor rental equalization (or when all geographic units with the same wage/rental ratio are treated as a single country), the following conclusions emerge:

1. Production in the most labor-abundant country will be concentrated on the most labor-intensive commodity or commodities, and production in the most capital-abundant country will include production of the most capital-intensive good. Country 1, in other words, is certain to produce commodity 1, and country  $m$  is certain to produce commodity  $n$ . For countries 2 to  $m - 1$ , those with higher capital/labor endowments will produce higher-numbered commodities than those with lower capital/labor endowments. It will never be so that a relatively more capital-abundant country will produce a more labor-intensive good than any less capital-abundant country (since it is assumed that factor rental equalization cannot occur).

2. If a country produces more than one commodity, the produced commodities will lie adjacent to each other in the factor intensity ordering. Whether the additional commodities produced are import substitutes or exports will depend on the country's factor endowment (in the absence of transport costs) and on demand conditions. It is clear that at least one produced commodity will be exported and that all nonproduced commodities will be imported. It is quite possible that all commodities domestically produced will be made in sufficient quantities to satisfy domestic demand and to export. It is also possible that imports of one or more commodities will result. Except for the most and the least capital-abundant countries, therefore, import-competing industries can lie on either or both sides of the factor intensity of export industries.<sup>6</sup> There will be no essential commodity characteristic that distinguishes import substi-

tutes from exports. The key distinction is between produced and nonproduced commodities.

3. If any two countries produce a common commodity without factor rental equalization between them, the more capital-abundant country will be found employing a more capital-intensive technique of production than the labor-abundant country, and the wage/rental ratio will be higher than in the labor-abundant country.

4. In general, the factor proportions explanation of trade will show up in the pattern of specialization of production rather than in the factor intensity of exports and import-competing goods. Countries in the middle of the factor endowment ranking will tend to specialize in producing commodities in the middle of the factor intensity ranking. They will import labor-intensive commodities from more labor-abundant countries and capital-intensive commodities from countries with relatively higher capital/labor endowments.

#### 4.1.3 Growth in One Country

As a first step in extending the model, it is instructive to examine how the pattern of production and factor prices would change if one relatively labor-abundant country started accumulating capital more rapidly than the rate of growth of its labor force, while international prices and other countries' factor endowments were constant.<sup>7</sup>

Straightforward application of the factor rental equalization and Rybczynski theorems yields the results. Recall that there are three possible initial conditions: (1) the country is specialized in the production of one commodity; (2) the country produces two or more commodities but no more than one in common with any single country; and (3) there is factor rental equalization with another country and two or more commodities are produced in common. Consider first case 1—complete specialization in one commodity. As capital accumulates relative to labor, the production process becomes more capital intensive, with an increase in the wage/rental ratio but continued complete specialization in the single commodity. As accumulation continues, the rental on capital continues declining until it is profitable to produce the next-highest-numbered commodity. After production of that commodity has started, continued capital accumulation results in shifting the composition of output toward the more capital-intensive commodity. At some point, production of the commodity initially produced ceases. During the period of producing both goods, the wage/rental ratio is constant, since international prices are given. When production becomes concentrated on the next-higher commodity, the wage/rental ratio starts rising again and continues until it is profitable to produce the next commodity.<sup>8</sup>

There is, then, a two-phase progression up the commodity chain.<sup>9</sup> In the phase when only one commodity is produced, the wage/rental ratio increases with capital accumulation, but the pattern of production re-

mains unchanged. In the phase of producing two goods, the wage/rental ratio is constant, but the structure of production is shifting among commodities. It is easy to see that starting from the initial position described in case 2 does not essentially alter the argument: initially, the composition of production would shift until the time when continued production of the more labor-intensive commodity was inconsistent with full employment at the existing wage/rental ratio; the wage/rental ratio would then start increasing, and production techniques would become more capital using.

Finally, there is case 3—that of factor rental equalization. Starting in such a position, output of the capital-intensive commodity would increase relatively faster than capital accumulated until production of the labor-intensive commodity ceased, and the story would then be the same as for cases 1 and 2.<sup>10</sup> In all three cases, as the country accumulating capital shifts its production structure to more capital-using goods, it must “meet” and “pass” some other countries along the way. During times when it begins producing new goods, there may be a period when factor rentals equal those of the country whose factor endowment is next most capital intensive to the country in question. Once that country is passed, specialization can rule again, but at some point the next country must also be met and passed. Indeed, in the context introduced above, with one country accumulating capital and all other countries unchanged, the accumulating country would eventually become the most capital abundant and would specialize in the production of one or more of the most capital-intensive commodities.

The two-stage progression here has strong implications for the pattern of trade and its changes over time that would be observed for a rapidly growing country: exports of labor-intensive commodities would gradually be replaced by exports of more capital-intensive commodities as the changing factor endowment altered the country’s comparative advantage. Whether a commodity was an export or an import substitute would depend on the factor endowment and the demand pattern, and there is no prediction about relative factor intensity at a point in time.

#### 4.1.4 An Agricultural Sector

Although the  $n$ -commodity model spelled out above may be a useful first approximation for trade in manufactured commodities, it is surely unsatisfactory for agricultural and other primary commodities, especially in the context of a discussion of developing countries’ comparative advantage. Moreover, everyone knows that one of the key features of countries with low per capita income is the very high proportion of national income, and even higher proportion of population, in the agricultural sector.

Jones (1971*b*) has developed a two-good, three-factor model of trade that can be adapted to take into account this aspect of reality. To avoid confusion later, it is useful to refer to sectoral outputs as being “goods,” in contrast to the  $n$  “commodities” produced within the manufacturing sector. One of Jones’s goods will be regarded as food, the only output of the agricultural sector, and the other will be the  $n$ -commodity output of the manufacturing sector. The distinctive feature of Jones’s model is that each good requires only two factors of production as inputs: one factor is specific to each sector, and one factor is mobile between the two sectors. For present purposes, labor is regarded as the mobile factor, employed in both manufacturing and agriculture, land is treated as the factor employed only in agricultural production, and capital is the factor specific to manufacturing.

Consider first the case with only one manufacturing commodity. For given (international) prices of the manufacture and food, an equilibrium is described by the following conditions: (1) equality of the wage between the two sectors; (2) full employment of all three factors of production, with the services of capital and land valued at their marginal products; and (3) competition among cost-minimizing firms within each sector. Unlike the two-by-two HOS model, factor rewards are not independent of factor endowments: for a given labor force, the wage, which is uniform, will be higher the greater the endowment of either capital or land, holding the other specific factor constant. For a given stock of land, the fraction of the labor force in agriculture will be greater the smaller the stock of capital. These results follow from the assumption of labor mobility and competitive factor rewards: if the stock of either land or capital increases, the marginal product of labor in that sector must rise. Maintenance of wage equality between sectors therefore implies that some labor must migrate from the other sector, which, with a given amount of the specific factor, implies a higher marginal product of labor in that sector, as well as reduced output.

Now consider what happens over time to a country faced with fixed international prices, still retaining the assumption of only one manufactured commodity. It is simplest to start by assuming an initial equilibrium with a zero capital stock and to investigate what happens if capital accumulation begins with a constant stock of land and an unchanging labor force.

In this initial no-capital-stock equilibrium, the wage will be determined by the land/labor ratio. The greater the labor force relative to the land, the lower will be the marginal product of labor. Presumably, some agricultural output would be exported in return for imports of manufactures. If a small amount of saving takes place, some labor must move from agriculture to manufacturing in order to maintain wage equality

between the sectors. The wage must rise from its initial equilibrium as the labor/land ratio falls with the shift of workers to the manufacturing sector. Note that if two different countries started capital accumulation with very different man/land ratios, the initial choice of techniques in their manufacturing sectors would differ, with the country that has the more favorable endowment of land using, even initially, techniques that require more capital per worker. That, in turn, implies that the increment of manufacturing output per unit of capital would initially be smaller in the land-rich country.

Once a manufacturing sector is started, further increases in the capital stock imply a rising wage/rental ratio, an increasing marginal product of labor in agriculture, and reduced agricultural output as the same quantity of land is combined with fewer workers. In the two-sector model the country would initially be a food exporter and a manufactures importer, regardless of the land/man ratio. With capital accumulation, there would inevitably (at constant world prices) come a point where the country shifted from being a net exporter of food to being a net exporter of manufactures.<sup>11</sup> The higher the initial land/man endowment, the greater would be the capital accumulation necessary to reach the crossover point and the higher would be the wage at which such a point was reached. For present purposes, however, the precise location of the crossover is largely irrelevant: the pattern of production within manufacturing will be independent of whether the country is a net exporter of food or of manufactures.

This can be seen by joining the basic two-sector, three-factor model to the  $n$ -commodity, two-factor model outlined above. In particular, let there be  $n$  manufacturing production functions, each of which uses labor and capital with constant returns to scale and diminishing marginal products to either factor, while the agricultural sector produces food, using labor and land in its production process, again with constant returns to scale and diminishing returns to either factor. World prices are again given, equality of the wage between industry and agriculture is assumed, and all factors are fully employed.

Diminishing marginal product of labor in agriculture implies that more labor will be supplied to the manufacturing (urban) sector the higher the urban wage. To see the properties (and comparative statics) of an equilibrium, let the urban capital stock be given and consider the conditions under which the country would produce manufactured commodities 1 and 2; the wage/rental ratio is implied by the relative prices of the two manufactured commodities (given by world prices). If, at that wage, the quantity of labor supplied from the agricultural sector is such that the urban capital/labor ratio lies between the factor proportions associated with the wage/rental ratios in the first and second industries, both commodities will be produced. By construction of the ordering of commod-

ities, the country's labor/capital proportions within manufacturing will be relatively high, and the country will have relatively low wages.

We now have a situation in which there is a capital/labor ratio for the country as a whole *and* a capital/labor ratio for the manufacturing sector. One might find two countries with comparable overall labor/capital ratios but very different wage/rental ratios, if one country was considerably more land abundant per man. The land-abundant country would have a higher capital/labor ratio in the manufacturing sector and a higher wage/rental ratio than the land-poor country. Conversely, identical wage/rental ratios might be observed if one country's overall capital/labor ratio was greater and its land/labor ratio less than the other's. In that case similar commodities would be produced by the two countries despite the diversity in their overall factor endowments. Paradoxically, for any given countrywide capital/labor endowment, the manufacturing sector's capital/labor ratio depends on the country's land/man ratio: the more land there is, the higher will be the wage for any given capital stock.

Suppose now that the wage/rental ratio implied by prices of manufacturing commodities 1 and 2 elicited an urban labor supply such that the overall manufacturing labor/capital ratio (given the fixed capital stock) exceeded the factor proportions that would be used in the first industry at that wage/rental ratio. It is clear that there would be an excess supply of urban labor. The equilibrium wage would therefore be below that associated with positive production levels for commodities 1 and 2. That would result in somewhat less labor being supplied to the first industry, but, even more important, it would imply that the commodity 1 is the only manufacture produced.

Consider, then, an equilibrium with wage equality between the urban and rural sectors, and manufacturing production specialized in the first commodity. The quantity produced might be insufficient to supply the domestic market, in which case it would be an import substitute (and the economy would necessarily export food), or it might exceed domestic demand, in which case it would be an export. Either way, it would be labor intensive relative to other manufactured commodities, which would be imported and not produced domestically.

Now examine what would happen if, from that initial equilibrium, an increment of capital were acquired. Capital deepening in the first industry would occur, thereby tending to raise the wage (inducing more workers to migrate to the urban area) and lower the rental on capital. The net effect would always be some degree of capital deepening within the first industry, because additional workers would migrate only at a higher wage. Thus capital accumulation would necessarily increase both the urban and the rural wage and lower the return on capital (and on land).

If capital accumulation continued, a point would be reached at which the wage/rental ratio rendered profitable the production of the second, as

well as the first, commodity. At that point continued capital accumulation would result in increased output of the second commodity and reduced output of the first commodity, following the Rybczynski theorem, and constant factor prices (with a constant urban labor force, also). At some point the capital/labor ratio would reach that found in the second commodity's production, specialization would be complete in the second commodity, and the wage/rental ratio would once again start increasing as further capital accumulation occurred.

In a world of constant prices with one country accumulating capital, one can readily extend the model to show that the country could "progress" from specialization in agriculture with no manufacturing activity to a situation in which the most capital-intensive manufactured commodities were produced. Note that the production of some food would continue throughout the process, although, as stated, the model implies decreasing food output throughout the capital-accumulation process (and, perhaps, a shift from food exports to food imports).<sup>12</sup>

It is also simple to consider the situation in which the marginal product of labor in agriculture is high enough so that, instead, specialization is somewhere further up the commodity ordering: even at an early stage of development, comparative advantage within manufacturing need not lie in labor-intensive commodities.

Several points should be noted. First, the distinction between poor and underdeveloped countries emerges clearly from the model. A "poor" country is one with an unfavorable land/man endowment. An underdeveloped country is one with a relatively small endowment of capital per person. An underdeveloped country, however, could conceivably have a higher per capita income and real wage than a "more developed" but poorer country. Second, a country abundantly endowed with land and therefore with a relatively high wage would not necessarily have a comparative advantage in labor-intensive manufactures even in its early stages of capital accumulation: the real wage at which persons would leave agriculture might be too high. In such an instance, the capital/labor ratio in manufacturing would be higher in the early stages of development than in a poorer country, while output per unit of capital and the rate of return on capital would be lower than in a lower-wage country. The apparent paradox of a high-wage, land-rich underdeveloped country or a land-poor, low-wage developed country may thus be explained: Carlos Díaz-Alejandro suggested in correspondence that Argentina and Japan in the 1920s may be prototypes.

Third, the supply of labor to the urban sector (quite aside from the issue of population growth, which can readily be incorporated into the growth implications of the model) will be relatively more elastic the smaller is the urban sector relative to the rural sector and the more elastic is the output of the agricultural sector with respect to labor.<sup>13</sup> Thus one

would expect comparative advantage to shift slowly in the early stages of growth, since small changes in the small manufacturing wage would elicit a relatively large change in labor supply from the large agricultural sector. For a constant rate of capital accumulation, therefore, one would expect to observe an increasing rate of increase in the urban real wage (and a commensurate change in the rate of change in the return on capital) and a decreasing rate of increase in the rate of growth of manufacturing output. An increasing rate of capital accumulation resulting from higher incomes would reinforce the tendency. “Early” development would therefore consist of the growth of the manufacturing sector, with relatively slow changes in the composition of output and the wage/rental ratio. “Later” development would witness a much slower rate of transfer of labor to the urban sector but more rapid changes in the wage/rental ratio and in the composition of manufacturing output.

#### 4.1.5 Transport Costs and Home Goods

Despite the many appealing features of the model spelled out above, a troublesome aspect is that it forecasts the production of relatively few manufacturing commodities at each stage of development. That may, of course, be an accurate prediction. How many constitute “few” depends on the number of commodities relative to the number of countries. If there are two hundred countries and five thousand commodities, failure of production patterns to overlap might still imply the production of a sizable number of individual manufacturing commodities in each country.

Incorporating transport costs into the model provides a partial basis for believing that a somewhat greater overlapping of production patterns is possible without factor rental equalization than is implied by the basic model. It also suggests that the process of growth will entail continuous shifting of output compositions and an increasing wage/rental ratio, rather than the two-phase progression spelled out above.

Assume that transport costs are a constant percentage of international price for all manufactured commodities. Domestic prices of exportables would be less than their international prices by the percentage that transport costs constitute of international price, while the domestic price of imports and domestically produced import-competing commodities would be an equal percentage above the international price.<sup>14</sup>

When domestic price can vary at a constant world price—within a range, of course—two things change. First, it is no longer necessary that production be concentrated in one or two manufacturing commodities only, and an import substituting sector becomes much more likely. The factor intensity of domestic production of import-competing goods will still be similar to that of exportables: for the country with the lowest manufacturing capital/labor ratio, import-substituting production will



generally be more capital intensive than export production, and conversely for the most capital-abundant country. For countries in the center of the endowment range, however, import-substituting industries' factor proportions are likely to lie on each side of that of the export industries.

Second, when domestic prices can vary within the range set by transport costs, there will be a slight change in the way the pattern of production will alter with increases in the capital stock. In particular, the prices of commodities will be free to change somewhat as capital accumulates. To see this, return to the example given in the last section, where it was assumed that a country with a low land/labor ratio (and therefore a low wage) began accumulating capital. It was asserted that such a country would initially produce commodity 1, the most labor-intensive manufacture, and that the wage rate would increase as capital accumulation continued until it became profitable to produce commodity 2. While that analysis remains correct, there would be an additional aspect to the process of capital accumulation: initially, the domestic price of commodity 1 could exceed the world price by the margin of natural protection afforded by transport costs. With capital accumulation, the wage would rise relative to the rental, but in addition the price of the commodity would decrease. Moreover, import-substituting production of the second manufactured commodity could start relatively sooner than was implied by the cycle of rising real wages followed by constant wages as production shifted between industries. This is because the domestic price of the second commodity could exceed its world levels. Thus the phase pattern described above would not be quite so pronounced; instead, relative price changes of domestically produced goods could absorb some of the alterations resulting from changed factor endowments in the urban sector.

With proportionate transport costs for all manufactured commodities, there is likely to be a range of commodities, on each side of the factor intensity of the country's exports (except where the country itself is in an extreme position), for which it would be profitable to produce for domestic consumption. Thus a moderately labor-abundant country exporting a commodity or commodities in the middle of the factor intensity range might produce import substitutes on both sides of the factor intensity of its export. It remains the case, however, that the goods it did not produce would require more extreme factor proportions than those it did produce.

If transport costs differ significantly among commodities, of course, the preceding analysis no longer holds. Some possibilities can, however, be dealt with. Suppose, for example, that labor-intensive commodities have higher transport costs as a percentage of international price than do capital-intensive goods. The following ought then to be the case: (1) for commodities more labor intensive than those exported by any particular country, the height of transport costs (as a percentage of international

price) should be correlated with the labor/capital ratio in the industry; (2) one would expect to observe relatively less specialization in countries with capital-abundant manufacturing sectors than in countries with labor-abundant manufacturing, since the former would tend to have more import-substituting activity; and (3) world exports would constitute a greater proportion of the world supply of capital-intensive commodities than of labor-intensive commodities.

Of course, if transport costs are sufficiently high, a commodity can become a “home good,” since international trade is virtually ruled out in all but exceptional cases. Many services, such as haircuts, medical care, and retail delivery of commodities, are generally thought to be labor intensive. However, there are other items, such as financial services, communications, and the like, that are probably equally location-tied and that seem to be capital intensive. The existence of home goods does not basically alter the propositions set forth above except in the ways it affects the basic two-commodity-model predictions.<sup>15</sup> If home goods factor proportions are at the world average for all commodities, home goods would tend to be capital intensive in labor-abundant countries and labor intensive in capital-abundant countries. When home goods are present, price-output responses of traded goods could become perverse, and thus some of the comparative-static propositions set forth above would not necessarily hold. Propositions about the comparative advantage of a country within manufacturing industries would still be valid, however, for any allocation of labor and capital to the production of traded goods.<sup>16</sup>

#### *4.1.5.1 Implications for Empirical Work*

The model above served as a theoretical basis for much of the empirical work undertaken by country authors. Several implications should be noted that are important in examining labor coefficients associated with HOS goods: (1) as was already mentioned, natural resource based trade should be excluded from the computation; (2) there is no presumption whatever, except for the countries at each end of the manufacturing-endowment spectrum or in the presence of protection, that the factor intensities of import-competing and export production will have any systematic relationship; (3) judgment of a country’s factor proportions should be based on its manufacturing capital/labor ratio and not on its overall endowment; (4) for countries not at either extreme of the manufacturing capital/labor range, any empirical evaluation of the pattern of trade must be based on a partitioning of that trade into the portion that is with countries higher up the endowment ordering and the portion that is with countries lower down.

The hypothesis emanating from the  $n + 1$ -commodity,  $m$ -country, three-factor HOS model, in other words, is that differences in factor endowments will show up in patterns of specialization: it is the capital-

intensive equipment that is imported and *not* domestically produced that reflects a very labor-abundant manufacturing sector's comparative advantage. It is this result that led to the distinction between import-competing goods and noncompeting imports.

On the basis of the model developed above, several tests of the generalized HOS explanation are possible: (1) if one knows the country's overall relative capital/labor ratio in manufacturing, the hypothesis is that the commodities it produces domestically will be ones that require inputs in approximately those proportions: commodities imported and not domestically produced will have factor proportions further away from the country's manufacturing endowment; (2) the pattern of trade, including exports, may well differ between countries on the two sides of the country's manufacturing endowment, especially when the presence of transport costs is taken into account; and (3) insofar as transport costs permit a wide range of domestic production, transport costs as a percentage of world price will have to be higher, the further the commodity is from the country's factor endowment within manufacturing.

Consider each of these tests in the case of a country with a relatively labor-abundant manufacturing sector. The HOS model then predicts several things: (1) That country will import commodities whose production functions are more capital intensive from countries with higher capital/labor ratios in their manufacturing sectors and commodities that are extremely labor intensive from the few countries with lower capital/labor ratios in their manufacturing sectors. Testing this proposition would require partitioning the country's imports into those from more labor-abundant areas and those from more capital-rich areas, and then applying to them the capital/labor ratios of any country that produces all commodities (the United States? Japan?). (2) Insofar as the country's manufacturing exports differ between the two groups of destinations, the capital intensity of exports will be greater to the more labor-abundant area, and conversely.<sup>17</sup> (3) The capital intensity of production of import-competing commodities will be positively associated with the level of transport costs (and, as will be seen below, tariffs) for commodities competing with imports from countries with higher capital/labor ratios in manufacturing, and conversely.

#### **4.2 The Effect of Commodity and Factor Market Distortions upon the Commodity Composition of Trade**

Thus far, attention has been centered upon the factor proportions explanation of trade as a hypothesis about the determinants of the production pattern for goods not based on natural resources under efficient resource allocation. If resource allocation were always efficient,

the task would be accomplished. The model developed above could be elaborated in numerous directions, but the basic propositions have emerged and empirical tests of it could be undertaken.

In some countries there is reason to believe that markets function fairly efficiently and that the model can therefore be tested along the lines sketched above.<sup>18</sup> Given that it was believed that distortions in the commodity and factor market might significantly affect the commodity composition of trade, however, an important question remains: How can one interpret the outcome of any examination of that pattern? To illustrate the difficulty, assume that, for a particular country where distortions are believed to be important, a pattern of trade in manufacturing emerges that does not conform to the specialization patterns set forth above. How can one distinguish between the possibility that the HOS model does not apply and the hypothesis that distortions so alter the trade pattern as to produce the observed result?

Research to date has thrown considerable light on what would happen if particular distortions were, in fact, observed. In this section those results are reviewed.

The procedure is as follows. It is assumed that the model developed in section 4.1 holds for a particular country.<sup>19</sup> To make exposition simple, it will be assumed that this country would, under efficient resource allocation, produce food and the first several manufacturing commodities: it is thus the country with the lowest capital/labor endowment in manufacturing and would, under an efficient allocation of resources, be a low-wage country. The question then is: Given particular distortions, what would be the observed pattern of production, and how would that pattern differ from the efficient one? In most cases the reader can readily generalize the results to cover countries elsewhere in the capital/labor endowment ranking. When application to countries in the middle of the endowment range may not be obvious, a note gives the relevant line of argument.

The questions now under consideration are the effect upon the structure of production of (1) distortions in the goods market so that domestic prices diverge from international prices by more than transport costs, and (2) distortions in the factor market so that domestic factor prices do not reflect the opportunity cost of employing those factors.

#### 4.2.1 Goods Market Distortions

The effects of goods market distortions are well known and can be spelled out briefly.<sup>20</sup> In general, one can readily devise testable hypotheses about the systematic relation between those distortions and the shifts in patterns of production that will result if factor markets function efficiently.

The production structure that would result from efficient resource

allocation can be altered by tariffs or subsidies to industries that would otherwise be unprofitable domestically.<sup>21</sup> When taxes and subsidies are used, it is possible not only to distort the structure of production, but to distort it so much that the “wrong” commodities are exported. This must sometimes occur in countries with large import substitution sectors built up under high levels of protection in circumstances where “export subsidies” are accorded only to new industries. In such cases industries that would be exporting under an efficient allocation may not produce at all, while others that might be not operating at all may be exporting.<sup>22</sup>

If all the incentives and market imperfections that result in distortions and inefficient production patterns are concentrated within the goods market, it still seems possible to devise a test to determine whether the HOS model of *efficient* production is valid: the net protection equivalents of all the various incentives, disincentives, and market imperfections should be positively correlated with the capital/labor ratios of the protected industries.<sup>23</sup> This is because, for the most labor-abundant country, which is the one on which the discussion is centered, the HOS model predicts that higher rates of protection will be needed to render domestic production possible, the higher the capital intensity of the industry. That the “wrong mix” of industries was producing would of course alter the equilibrium wage/rental ratio, but production of commodities that were too capital intensive for an efficient pattern of production would result in a decline in the equilibrium wage/rental ratio, thereby rendering the cost disadvantage of capital-intensive industries even greater than they would be at the wage/rental ratio associated with an optimal allocation of resources.<sup>24</sup>

When tariffs (and tariff equivalents) are the only distortion in the system, the correlation between protection and factor intensity should still hold. However, reversal of commodities is not possible, and thus the predictions of the HOS model would be observable. Under tariff protection, some industries would be producing that would not produce under an efficient allocation. It is not possible, however, to turn an industry that would be an exporter under an efficient allocation into a nonproducing industry. Protection can cause some resources to be used in import substitution that would otherwise have been employed in producing the commodities for export. However, the most that production can be diverted is to the point of autarky: tariffs can raise the internal price of commodities and thereby render their production for the domestic market profitable, but they cannot induce exports of those commodities at the lower world prices.

As long as exporting industries do not receive subsidies, trade patterns could not be reversed while factor markets continued to function efficiently. One could therefore still test the HOS model: the factor intensity of nonproduced commodities would be contrasted with the factor inten-

sity of exportables and import substitutes not receiving protection. One would observe the manufacturing sector of the labor-abundant country producing the most labor-intensive commodities for export. In addition, of course, one could test for the relationship between the capital intensity of industries and the height of protection.<sup>25</sup> In the event that the labor-abundant country was not exporting labor-intensive manufactures, one could reject the factor proportions explanation of trade even though tariffs were used to protect domestic industry. Likewise, if the height of protection necessary to induce domestic production was not positively correlated with the capital intensity of the protected industries, that again would constitute grounds for rejecting the HOS model.<sup>26</sup> Of course, with subsidies to particular exports (or, as in some countries, requirements that firms export certain portions of their output in return for import licenses), comparison of the factor intensity of a country's exports with that of nonproduced commodities might reveal that either exports or nonproduced commodities were more capital intensive. However, the correlation between the height of the protective equivalents and the capital intensities of the various industries should still be positive, and one should be able to test the HOS model directly against observable data within the country.

#### 4.2.2 Factor Market Distortions

The more difficult case is the one in which commodity prices are undistorted, that is, equal to world prices, while the prices of factor services differ from those that would prevail under perfect competition in factor markets.<sup>27</sup> The case is the precise opposite of that for commodity market distortions: when the distortions in factor markets are firm- or industry-specific, as with credit rationing, bureaucratic allocation of licenses for importing capital goods, and case-by-case decision-making on tax exemptions and subsidies, it is usually not possible to infer anything about the efficient pattern of trade from direct observation of the data. Firm- or industry-specific variations in factor prices are equivalent to subsidies and taxes; when such specificity occurs, the observed pattern of trade need not bear any relation to an efficient one.<sup>28</sup>

However, when the factor market distortion can be characterized in some systematic way, in some circumstances inferences can be drawn that make it possible to ascertain how the observed pattern of trade is related to an efficient one. By "systematic characterization" is meant departure from only one of the efficiency conditions for the allocation of factors of production among alternative uses. For example, if payment to one factor is uniform across all activities, while there are two different returns to the other factor with one subset of all activities paying a higher return than the other subset, the effects of that differential on resource allocation can be analyzed. Another systematic type of distortion occurs if the

return to one factor is pegged above the level that would prevail under competitive conditions, with the result that the factor is not fully employed.

Since, within the manufacturing sector, only the wage/rental ratio affects resource allocation, the effects of the capital and labor market distortions can be analyzed as an increase in the wage/rental ratio above its efficiency level.

Factor market distortions may significantly affect observed patterns of trade. When certain types of systematic factor market distortions are present, a finding that production and exports are concentrated in a capital-intensive industry or group of industries by a labor-abundant country is no longer *prima facie* cause to reject the factor proportions explanation of trade. Nor, for that matter, is a finding of a labor-intensive pattern of production sufficient cause to accept it. Indeed, in the context of the standard two-commodity, two-factor HOS model, it has been shown that a difference in the wage/rental ratio paid by two industries may bring about any of the following results: (1) the “right” commodity will be produced and exported with the “right” factor intensity; (2) the “right” commodity will be produced and exported with the “wrong” factor intensity; (3) the “wrong” commodity will be exported with the “wrong” factor intensity; (4) the “wrong” commodity will be exported with the “right” factor intensity. Suppose one observed a production and export bundle of highly capital-intensive commodities in a labor-abundant country in which factor market distortions were thought important. One could not determine without further investigation whether this pattern was observed because capital/labor substitution had occurred in the export industry, causing it to be more capital intensive than it would be at a common wage/rental ratio with other sectors; because import-competing industries or nonproducing industries were the ones that should be exporting under an efficient allocation; or because the HOS model was inappropriate.

One of the interesting lessons of this distortion literature is that it is not enough to say “distortion”: three separate types of distortion have so far been analyzed. Each case has been developed in the context of a two-commodity model, since the authors have had in mind an urban and a rural sector, and application of these analyses to the model of section 4.1 requires identification of the source of the distortion. In the first case, an exogenously imposed real minimum wage applies over the entire economy (with open unemployment when the real minimum wage is binding). This case readily extends to the  $n$ -commodity model by assuming a wage floor across the entire economy.<sup>29</sup> In the second case, based upon the Todaro (1969) and Harris-Todaro (1970) model of labor markets, the urban wage is above the rural wage, and the unemployment rate clears the labor market; in effect, the expected urban wage (equal to the actual

urban wage times the probability of finding work, adjusted for the length of time it takes to do so) is equal to the rural wage. In applying this distortion model to the  $n$ -commodity, two-sector case, the natural interpretation is that there is a minimum real wage in the urban sector and thus a variable differential in the wage between the rural and urban sectors, with open unemployment. In the third, and probably most thoroughly explored, case, a two-commodity, two-factor economy with full employment has a wage/rental ratio in one industry that differs by a constant multiplicative factor from the wage/rental ratio in the other industry. Two alternative interpretations of this case are possible: (1) the wage differential in question can be between the urban and rural sectors; or (2) there may be an organized, large-scale sector within manufacturing in which wages are equal to those in the rural sector. This latter interpretation would correspond somewhat to the notion of a “modern” and a “traditional” sector within manufacturing.<sup>30</sup>

The task at hand is to apply results obtained in the literature for the two-commodity, two-factor case to the two-sector,  $n$ -manufacturing industries, three-factor model for a single country.

#### 4.2.2.1 *An Economywide Real Wage Floor*

It is simplest to start with the case in which there is an economywide wage/rental ratio above that which would prevail under competition and perfect factor markets.<sup>31</sup> It is immaterial whether the distortion results from minimum wage legislation, union behavior, or other causes. Brecher (1974) has explored this case in the two-by-two context in terms of a real minimum wage, a practice that is followed here. The analysis holds equally, however, should the rental on capital somehow be pegged above its equilibrium level.

In the Brecher model, the locus of competitive outputs (LCO) coincides with the transformation curve until the point at which the wage implied by the relative price of the two commodities equals the real minimum wage; it then becomes a Rybczynski line from that point to complete specialization in the capital-intensive commodity; finally, it moves back toward the transformation curve as output of the capital-intensive commodity increases. Naturally, employment decreases from the point at which the locus of competitive outputs deviates from the transformation curve until the point of specialization in the capital-intensive commodity, then increases until full employment is reached at the point at which the transformation curve and the locus of competitive outputs coincide with specialization in the capital-intensive good.

The situation is depicted in figure 4.2a. The set of efficient production possibilities is the transformation curve  $AD$ . If an initial, efficient free-trade equilibrium is at point  $B$ , where production is concentrated in  $X$ , the labor-intensive commodity, the set of other outputs that can be



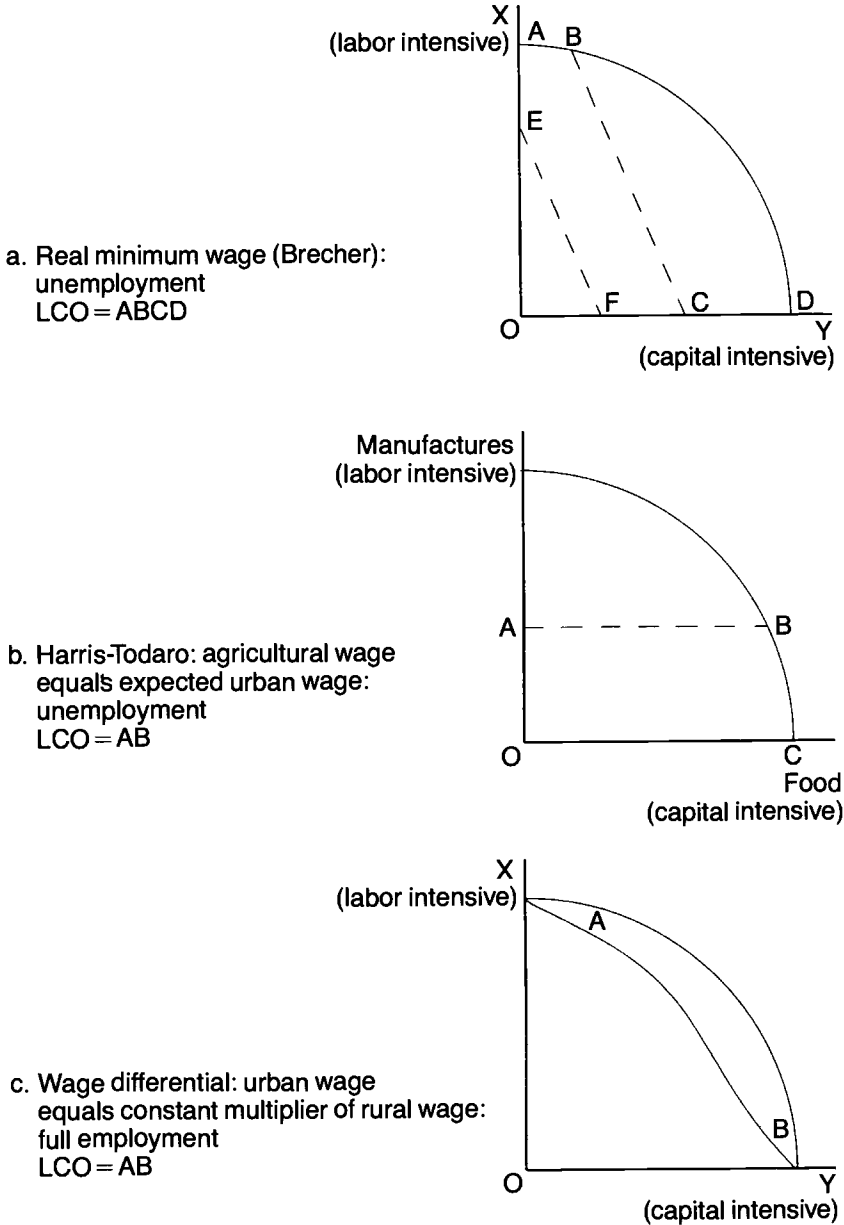


Fig. 4.2 Locus of competitive outputs (LCO) under differing assumptions about the nature of distortions.

produced under profit-maximizing behavior by firms with the commodity prices implied by the slope of the tangent to point *B* (not drawn) is the line *BC*. Along *BC*, both commodities are produced, and employment declines as the output of the labor-intensive commodity decreases. At point *C* there is complete specialization in the capital-intensive commodity, *Y*. Curiously enough, as production of *Y* increases from *C* to *D*, employment is increasing and the production technique employed in *Y* is increasingly labor intensive.

To understand the Brecher model, it is useful to imagine that a minimum real wage law is passed, with the real wage denominated in terms of the labor-intensive good. The Rybczynski line must shift to the left. A sufficiently high real wage will make full employment with specialization in the labor-intensive commodity impossible. Such a situation is illustrated in figure 4.2*a* by the locus of competitive outputs described by *EFD*. That locus is associated with a higher real minimum wage than the locus described by *ABCD*. With the minimum real wage associated with *EFC*, full employment could be attained only with specialization in the capital-intensive commodity, and that could occur only if there were a sufficiently high price for the capital-intensive good to maintain the real wage in terms of the labor-intensive commodity. Of course, if the real minimum wage were increased without any change in commodity prices, production of the labor-intensive commodity would decrease, but the economy would not become specialized in producing the wrong commodity, and unemployment would simply increase as the real minimum wage was increased.

Three features of the model are especially relevant for present purposes: (1) within this model in its two-commodity form, it is possible that the “wrong” commodity will be produced and even that there will be specialization in it; (2) the higher the real wage, the greater is the likelihood of wrong specialization; and (3) at a sufficiently high real wage, full employment is possible only if the price of the capital-intensive good is sufficiently high *and* the real wage is fixed in terms of the labor-intensive commodity.<sup>32</sup>

Applying the Brecher model to the two-sector, three-factor manufacturing commodities model developed in section 4.1.1.1 is relatively straightforward. If there is an economywide real wage and the stock of capital is independent of the level of real output, a higher real wage will be associated unequivocally with a smaller level of urban employment *and* a lower level of agricultural employment.<sup>33</sup> At given international prices, a given capital stock and a real wage entirely determine the industry (or industries) in which it will pay to specialize. The higher the real wage, the more capital intensive the industries of specialization will be, and the lower will be the real return on capital.<sup>34</sup> From this it follows immediately that employment must be less than in the absence of the distortion.

Several consequences of the fixed-real-wage model are immediately apparent. First, since both agricultural output and manufactured output must fall with increases in the real wage, it is not clear what will happen to the agricultural/manufactures balance of trade: it could either increase or decrease. A country that might be a net importer of food under an efficient allocation of resources might become a net exporter, or conversely. There is no a priori basis on which to assign likelihoods to either outcome. Within manufacturing, however, it is clear that the higher the real wage, the more capital intensive will be the industries within which production will take place, and as long as relative prices of manufactures remain at free-trade levels, the more capital intensive will be the techniques of production used within those industries. It is not possible for the factor intensities of produced commodities to reverse; that is, it is not possible that an industry that would be labor intensive under an efficient allocation could become capital intensive with a higher minimum wage.

It would thus appear that when the entire economy is operating subject to a minimum real wage constraint, there is no possibility of industries reversing factor intensities. Therefore, if the most labor-abundant country was found to be exporting the most labor-intensive goods when it was subject to a minimum wage constraint, one could be confident that the same outcome would apply under an efficient allocation. If that country was exporting manufactured commodities that were not the most labor intensive, however, there would be a question whether the distortion changed the pattern of production or whether the HOS model did not describe an efficient allocation. One could not ascertain whether the failure to hold of the factor proportions hypothesis called into question the validity of the model or was due to the real minimum wage, and direct observation of data would not provide a means to distinguish between hypotheses. Simulation of optimal allocations, examination of changes in production patterns before the imposition of the real-wage constraint, or other means would have to be devised to test whether the HOS theorems would hold under optimal resource allocation.

#### 4.2.2.2 *Fixed Urban Real Wages*

The second model, with a fixed real wage in the industrial sector above that in the rural sector, can have the same effects within the manufacturing sector as the economywide fixed real wage. The production pattern actually observed might be one in which the manufacturing sector was specialized in the wrong commodities. The higher the fixed urban wage, the more the production structure would shift toward more capital-intensive commodities, given international prices. As with the uniform wage, however, commodities that were capital intensive under the real wage constraint would also be capital intensive at free trade.

However, the fact that the Harris-Todaro model posits a difference in the wage/rental ratio between the urban (manufacturing) and rural sector

adds a twist to the model: it is possible that the labor intensity of agriculture and manufacturing might be reversed. Suppose, for example, that industry were labor intensive at free trade.<sup>35</sup> As the real minimum wage applying to the manufacturing (urban) sector rose, the quantity of labor employed in the urban sector would decline. At some critical wage, the labor intensity of the manufacturing sector would equal that in the rural sector.<sup>36</sup> How soon this occurred would depend on what happened to rural employment as the urban wage rose. If total workers in the city, employed plus unemployed, increased as the wage increased, then the “crossover” would be relatively slow in coming; agriculture, as well as industry, would become less labor intensive with increases in the real wage. If, however, urban employment fell sharply with increases in the real wage, it is possible that agricultural employment would increase as urban employment fell. In such a case agriculture would become more labor intensive while manufacturing was shifting to production of more capital-intensive commodities (and substituting capital for labor within each producing industry), and the point at which the two labor intensities crossed would be attained more quickly.

The locus of competitive outputs under an urban wage constraint is illustrated in figure 4.2*b*. There it is assumed that manufacturing would be labor intensive in the absence of a real wage constraint, but that the fixing of the real wage sets the manufacturing output level at *OA*. The locus of possible output points is therefore the line *AB*, and the point *B* would be infeasible unless the real wage in agriculture happened to equal that in industry there. An increase in the urban real wage would shift the line *AB* downward. Thus the Harris-Todaro model differs from the fixed-real-wage model in its implications for the possibility of reversing factor intensities between agriculture and manufacturing. That may be of considerable importance in a number of contexts if it is believed that the Harris-Todaro description of labor-market conditions is valid. Even if it is appropriate, however, the analysis of comparative advantage and the effects of the distortion within the manufacturing sector can be carried out as in the Brecher model: a manufacturing wage rate above that under an efficient allocation would easily lead to concentration of production in commodities that were more capital intensive than the country’s situation would render optimal. Such a circumstance could not, however, lead to a reversal of factor intensities, and if the country’s production and trade appeared to conform to the HOS model, this would confirm the HOS hypotheses.

#### 4.2.2.3 *Wage Differential within Manufacturing*

The most analytically interesting of the three cases of distortions is the two-commodity, two-factor model in which the wage/rental ratio in one industry is a constant multiple of that in the other, while full employment of both factors always prevails. For application to the *n*-manufacturing-

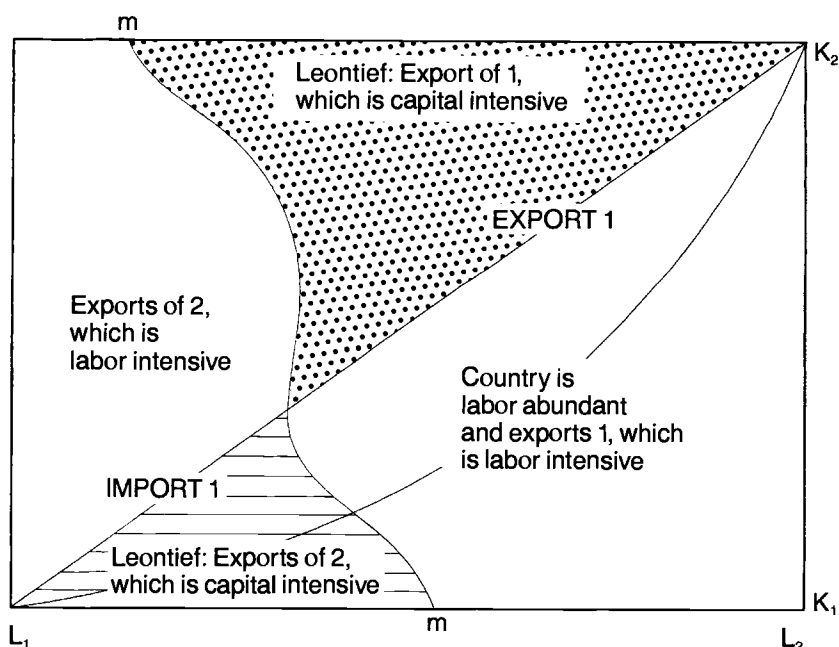
industries model, the case is of interest if one subset of the  $n$  industries has the same wage as the agricultural sector while the other subset pays a different, presumably higher, wage.<sup>37</sup> If, for example, the chemical, basic metal, and machinery industries are favored, then the constant-wage-differential model developed by Johnson (1965), Jones (1971a), Herberg and Kemp (1971), and others would apply.<sup>38</sup>

The locus of competitive outputs in the two-commodity, two-factor model is represented in figure 4.2c by the line  $AB$ , which must everywhere, except at the two complete specialization points, lie inside the production-possibility curve. This follows immediately from the fact that the marginal rate of substitution among the two factors of production is different in the two industries, and it would therefore be possible to attain more of both outputs by reallocating factors between them at any point at which both commodities are produced.

The problem, in the full-employment, constant-differential case, is that it is no longer possible, with such a distortion, to identify the direction of the change in output that will result from a change in relative prices of the two commodities. It is possible, for example, that the price of one commodity might increase, and that the competitive response would be for output of that commodity to decrease and output of the other commodity (whose relative price had fallen) to increase.

The reason for this can be most easily understood with the aid of figure 4.3.<sup>39</sup> The Edgeworth box drawn there is based on the production possibilities between two commodities, 1 and 2, with a constant stock of labor and capital. In the absence of wage differentials (i.e., under conditions of efficient production), commodity 1 is assumed to be labor intensive. The locus of efficient output points (the curved line) lies below the diagonal representing equal factor proportions in both industries. Every point in the Edgeworth box corresponds to a particular set of input combinations and outputs. Moving to the east and to the north represents greater output of 1, and there is a given real income associated with each output point. For the sake of exposition, assume that demand patterns associated with those output points and real income levels mean that commodity 1 will be exported to the right of the  $mm$  line and will be imported to the left of the  $mm$  line.

Two distinct cases must be analyzed. In the first, the labor-intensive industry must pay higher wages than the capital-intensive industry. In the second, the lower wage/rental rate applies to the labor-intensive industry. Taking the first case, start with wage/rental equality and then introduce a differential. The labor intensity of industry 1 will diminish and that of industry 2 will increase. As the differential increases and commodity prices adjust, at some point, industry 1 will become capital intensive in the physical sense; that is, it will employ more capital per worker than industry 2. At that point the physical factor intensities are reversed, so



**Fig. 4.3** Production possibilities between two commodities with a constant stock of labor and capital.

that production will take place somewhere above the diagonal representing equal factor proportions.<sup>40</sup>

There are now four possibilities:

1. The wage differential might not be sufficient to reduce production below consumption or to reverse factor intensities, so that the country might be operating below the diagonal and to the right of the *mm* line. In that case the differential would not be sufficient to alter production and trade patterns away from “true” comparative advantage. This corresponds to the white area below the diagonal in figure 4.3.

2. The wage differential might not be sufficient to reverse factor intensities, but it might result in an increase in production of commodity 2 and a reduction in production of commodity 1, to a point to the left of the *mm* line. In that case the country’s production would have altered enough so that commodity 2 became the export commodity. Inspection of the factor proportions of the two industries would reveal that the capital-intensive commodity was the export. The finding of Leontief paradox would result. This is the case where the country exports the “wrong”

commodity with the “right” factor proportions. It is the horizontally striped area of figure 4.3.

3. The wage differential and accompanying price changes could be sufficient to move the country across the diagonal but leave production to the right of the *mm* line. In that case commodity 1 would be exported, but empirical estimation would show that commodity 1 was the capital-intensive commodity, and thus the “perverse” factor intensity of exports would be found—another Leontief-paradox area—in which the “right” commodity is exported with the “wrong” factor proportions.<sup>41</sup> This is the case illustrated by the shaded area of figure 4.3.

4. The distortion could be sufficient to render commodity 1 capital intensive and to reduce output sufficiently so that commodity 2 was exported and labor intensive. In this final case one would find that exports were indeed labor intensive and thus confirm the HOS comparative-advantage model! It corresponds to the unshaded area above the diagonal in figure 4.3. Here the “wrong” commodity is exported with the “wrong” factor proportions.

It thus appears that, in the two-commodity, two-factor model with full employment and a constant differential in factor rewards, anything can happen. The question, of course, is how these results can be extended to the *n*-manufacturing-commodities, two-sector model of efficient production developed in section 4.1. As already noted, the differential must lie within the manufacturing sector, so that some manufacturing industries are confronted with a higher wage/rental ratio than the rest. If that is the situation, few conclusions are possible unless the factor market distortion is somehow systematically related to the factor intensity ordering of the manufacturing industries. If it is, two cases can be analyzed.

1. Suppose that capital-intensive industries pay a higher wage/rental ratio than labor-intensive industries.<sup>42</sup> Then, if a country’s comparative advantage under an efficient allocation lay in production of commodities in the middle of the factor intensity ordering, say commodity 5, one should observe specialization of production in commodities with disparate factor proportions on each side of the “natural” specialization point. It might be, for example, that the lower wage/rental ratio that would result for labor-intensive industries would enable industry 3 to become more profitable than 5, while the lower rental/wage ratio confronting capital-intensive industries caused industry 7 to bid resources away from industry 5. Thus, one would expect to observe a production pattern where industries of dissimilar factor intensities were profitable.

2. Suppose that labor-intensive industries pay a higher wage/rental ratio than capital-intensive industries.<sup>43</sup> If countries specialized in the commodities forecast by the HOS model, one could accept that as verification of the model: this is the case in which reversals could lead to the Leontief-paradox results even when the HOS model was correct, but

in which specialization in production of the “right” commodities could not result from distortion if the HOS model was valid.

Beyond these cases little can be said, although one can hope that examining specific distortion patterns that did not conform to either of those two cases might provide ways of testing the HOS model.

#### 4.2.3 Summary

What emerges from consideration of the literature on distortions is an entirely new set of possibilities that must be evaluated when examining the employment implications of alternative trade strategies: the empirical measures appropriate under efficient allocation cannot be uncritically accepted in the presence of distortions. It is probably a valid first approximation that most industrialized countries’ factor markets may not be sufficiently distorted to significantly affect production and trade patterns and factor proportions. The same may or may not be true for the developing countries.

The presence of tariff interventions and export taxes does not create fundamental difficulties for testing the factor proportions model. Indeed, some testable hypotheses about the relationship between factor proportions and the height of protection emerge to provide yet another way of testing the factor proportions explanation of trade. Subsidies to exports can influence the trade pattern in any conceivable direction and thus prevent testing. When factor market distortions are significant, all sorts of possibilities arise: a labor-abundant country, which would be exporting labor-intensive commodities under an efficient allocation, might in fact export commodities whose capital intensity was substantially higher than that. Other patterns, also at variance with the efficiency model, are possible, too.

In general, when there is a distortion between the manufacturing and rural sectors, some means of testing for the separate effects of distortion and efficiency influences on trade patterns are available. When the factor market distortion is within the manufacturing sector, however, no single set of observations can enable identification of the separate contributions of each factor. The important lesson is that, in the presence of factor market distortions that are thought to affect resource allocation significantly, one cannot draw any inferences about the efficient commodity composition of production and trade and its factor proportions solely from observing the actual pattern of production and trade.