

*Chapter 1*

# THE POSITIVE THEORY OF INTERNATIONAL TRADE

RONALD W. JONES

*University of Rochester*

and

J. PETER NEARY\*

*University College Dublin*

## Contents

1. Introduction	2
2. Models of trade	4
2.1. The exchange model	7
2.2. The Ricardian model	10
2.3. The Heckscher-Ohlin model	14
2.4. The specific-factors model	21
2.5. Extensions	27
3. Multi-level trade	31
3.1. Trade in intermediates and natural resources	31
3.2. Trade in factors	37
3.3. Trade in technology	42
3.4. Trade in securities	43
4. Multi-behavioral trade	45
4.1. Market distortions	45
4.2. Increasing returns	48
4.3. Imperfect competition	50
5. Concluding remarks	53
References	53

\*This paper was begun while the authors were visitors at the International Institute for Applied Systems Analysis, Laxenburg, Austria. We are grateful to this Institute and to the National Science Foundation under grant no. SES-7806159 for support and to J.N. Bhagwati, A.V. Deardorff, A.K. Dixit, W. Ethier, M.C. Kemp, P.B. Kenen, F.P. Ruane, and L.P.F. Smith for helpful comments.

## 1. Introduction

The theory of international trade is one of the oldest subfields of economics and its central concerns remain those of Ricardo. Nevertheless, in recent years the field has not stood still, but has exhibited an expansion of the range of topics studied and of the analytical tools brought to bear on them. In this chapter we attempt to present an overview of the present state of positive trade theory, concentrating on developments since the surveys of Mundell (1960), Bhagwati (1964) and Chipman (1965–66) while at the same time drawing attention to the continuity in the development of the subject. We begin in this section by outlining the scope of the field as we see it and the criteria which have guided our selection of topics to be covered.

As the title of our chapter indicates, we confine our attention to the positive theory of international trade, leaving normative questions for Chapter 2. Although the distinction is somewhat arbitrary, a reasonably clear line of demarcation can be drawn. As a rough guideline, questions concerning the effect of exogenous or policy changes on the level of aggregate real income or dealing with the ranking of alternative policy instruments will be considered the province of normative trade theory. By contrast, questions concerning the effect of exogenous or policy changes on the composition of outputs, relative prices, trade flows, or on the domestic distribution of real income will be considered within the realm of positive trade theory.

While trade theory makes extensive use of general-equilibrium theory, with its concern for interactions among markets, the key feature which distinguishes it is its recognition that not all commodities and factors are equally mobile. This phenomenon of differential mobility can take many forms. From Ricardo onwards, much of trade theory has been conducted in terms of the Classical mobility assumptions: all final goods are tradeable between countries whereas primary inputs are non-tradeable, though fully mobile between different sectors of the domestic economy. However, a great deal of recent work has been concerned with examining the consequences of departures from these assumptions.

Another feature which characterizes international trade theory is its focus on applied questions, making it natural to conduct analysis in the context of relatively small-scale models. This is not to say that trade theory is wedded to any particular model. For example, despite its dominance in the 1960s, the Heckscher–Ohlin model has not supplanted the Ricardian model, nor has it in its turn been eclipsed by the recent revival of interest in the specific-factors model. Rather, positive trade theory uses a variety of models, each one suited to a limited but still important range of questions. While this eclectic approach is sometimes

criticized, since it is easy to show that the propositions derived from any one model are not necessarily robust with respect to relaxations of that model's assumptions, it seems to be a more satisfactory way of yielding useful insights and suggesting hypotheses for empirical testing than the attempt to construct a general model which encompasses all others as special cases.<sup>1</sup>

**Among the issues with which positive trade theory deals is the question of the determinants of the pattern of trade, to which the proximate answer usually given is still that of Ricardo: namely, the principle of comparative advantage,** with its focus on a comparison among autarkic relative prices in different countries. In the case of two commodities and two countries the principle is both easy to formulate and incontrovertibly true:<sup>2</sup> each country will tend to export under free trade that commodity which has the lower relative price in autarky. However, with more than two commodities the appropriate way to generalize the principle is not immediately apparent. It is tempting, for example, to argue that if commodities are ranked by their relative price ratios in autarky in the two countries, demand conditions will determine a critical ratio such that, when trade is opened up, the home country will export all commodities whose autarky relative price is below this ratio and import all other commodities. This assertion is correct in the Ricardian case of constant costs, but as Drabicki and Takayama (1979) and Dixit and Norman (1980, pp. 95–96) have shown, it need not hold in less special cases. However, the more paradoxical aspects of their counter-examples rely on the presence of strong complementarity in demand. In any case, whatever the pattern of substitutability or complementarity, the principle of comparative advantage may be reformulated in terms of a *correlation* between differences in autarky price levels and net export volumes for different commodities, as Deardorff (1980) and Dixit and Norman (1980) have shown.

**While the principle of comparative advantage may thus be defended as a basic explanation of trade patterns, it is not a primitive explanation, since it assumes rather than explains inter-country differences in autarkic relative prices.** Much of trade theory is therefore concerned with investigating alternative sources of these differences, and each such source has implications in turn for the effect of the opening up of trade on the structure of production and on the domestic distribution of income. The same questions can also be posed not in terms of a comparison between autarky and free trade but in the context of disturbances to

<sup>1</sup>This viewpoint is not shared by all trade theorists. For example, Pearce (1970, p. 17) states “There is but one world and only one model is needed to describe it.”

<sup>2</sup>Nevertheless, the principle, with its denial that absolute superiority in productive power determines the pattern of trade, remains suspiciously counterintuitive to most non-economists. Samuelson (1969) recalls the time he was challenged by the mathematician Stanislaw Ulam to “name me one proposition in all of the social sciences which is both true and non-trivial.” Samuelson remarks that years later he thought of the appropriate answer: the Ricardian theory of comparative advantage. “That it is logically true need not be argued before a mathematician; that it is not trivial is attested by the thousands of important and intelligent men who have never been able to grasp the doctrine for themselves or to believe it after it was explained to them.”

an initial trading equilibrium. In discussing these and other issues, our strategy is to present in Section 2 an overview of a number of alternative models, stressing the complementarity between them and the differences in the questions which each is well suited to answer. For the most part, this section stays within what we call the “Classical paradigm.” This encompasses not only the Classical assumptions about goods and factor mobility already mentioned, but also neglects intermediate stages in the production hierarchy and assumes that all agents are atomistic, operating in an undistorted and competitive environment in which technology exhibits constant returns to scale. More recent work which relaxes these assumptions, allowing for trade at different levels of the production spectrum and for departures from competitive behavior, is reviewed in Sections 3 and 4 respectively.

Inevitably, throughout the chapter there is some overlap with other contributions to this volume (though not on empirical matters, which we leave to Chapter 10). In general, we go into less depth on individual topics than other contributors, attempting instead to fit recent extensions into an overall framework which provides a coherent view of the field. Moreover, a survey of a wide field such as this cannot hope to be anything other than highly selective. Without attempting to provide a comprehensive coverage, therefore, we hope to give the flavor of a subject which remains a vibrant and fruitful source of theoretical insight and testable hypotheses.

## **2. Models of trade**

Although the theory of international trade combines elements of demand behavior with production structure in a general-equilibrium context, it is primarily variations in the specification of the production side that distinguish the basic models of trade. Section 2.1 describes the uses to which the “exchange model” has been put; this model can be interpreted as one in which each of two factors is used to produce a separate commodity so that no intersectoral factor mobility is allowed. Section 2.2 describes the Ricardian model, the polar opposite of the exchange model in that only one productive factor (labor) is employed, but this factor can be freely reallocated between sectors so as to maximize its earnings. Section 2.3 presents the basic propositions of the Heckscher–Ohlin model, the model most frequently used in positive trade theory, whereas Section 2.4 deals with the specific-factors model, which focusses on asymmetry in the degree of factor mobility between sectors. Finally, Section 2.5 extends these models to consider some properties of higher dimensional cases as well as the possibility of joint production.

The production structures of the basic trade models discussed in this section have many properties in common. For each country it is possible to relate the value of the national product,  $Y$ , to the vector of factor endowments,  $v$ , and the

vector of final commodity prices,  $p$ , where competition ensures that the composition of output (shown by the vector,  $x$ ) maximizes the value of  $Y$  at those prices.<sup>3</sup> Price-output responses are normal, in the sense that no commodity can fall in supply if its price rises (and all other prices and endowments remain constant). Similarly, an increase in the endowment of any factor of production cannot raise that factor's return if commodity prices and all remaining endowments are held constant. Furthermore, a basic relationship – that of *reciprocity* – equates the effect which an increase in the endowment of factor  $i$ <sup>4</sup> has on the output of commodity  $j$  (all commodity prices constant) to the effect which an increase in commodity  $j$ 's price has on the return to factor  $i$ .

The models of trade described in Sections 2.1–2.4 differ from one another in the specification of the numbers of factors and commodities and the degree of intersectoral mobility of the factors. They all share, however, the requirement that the economy's demand for inputs to produce commodities not exceed the availability of factors in the endowment base, and the stipulation that in a competitive equilibrium the unit costs in any activity do not fall short of market price. Furthermore, we postpone our discussion of intermediate goods and joint production.<sup>5</sup> Throughout we generally assume that factor endowments are given. This rules out international trade in productive factors (see Section 3.2), the possibility that the local supply of factors may respond to changes in factor rewards,<sup>6</sup> or the possibility that current production affects future factor supplies.<sup>7</sup> If all final commodities are traded on world markets, the commodity price vector,  $p$ , as well the factor endowment vector,  $v$ , can be treated as exogenous for a small open economy. But often trade models allow a subset of commodities to enjoy only a national market; even for a small open economy the  $p_j$ 's for non-traded goods thus depend endogenously upon local demand conditions.

The study of models with non-traded goods has expanded enormously in recent years, in part because of their relevance to macroeconomic policy in small open

<sup>3</sup>Formally,  $Y = g(p, v) = \max_x [p'x : F(x, v) < 0]$ , where the aggregate production possibilities set defined by the function  $F(x, v)$  is convex. The national product function was introduced by Samuelson (1953) and its properties have been examined under a variety of assumptions by Chipman (1972), Diewert (1974), and Dixit and Norman (1980) among others.

<sup>4</sup>The reciprocity relationship is due to Samuelson (1953) and discussed, *inter alia*, by Jones and Scheinkman (1977). Referring to the previous footnote, outputs and factor prices are reflected in the partial derivatives of the national product function when these are well defined (as when the number of factors is at least as great as the number of commodities):  $x = g_p$  and  $w = g_v$ .  $g$  is a concave function of  $v$  (implying  $g_{vv}$ , or  $\partial w / \partial v$ , is negative semi-definite) and a convex function of  $p$  (implying  $\partial x / \partial p$  is positive semi-definite). Reciprocity follows from the symmetry of the matrix of second derivatives of  $g$ .

<sup>5</sup>Section 2.5 considers joint production, while Section 3.1 allows the existence of intermediate goods in the production spectrum as well as international trade in these goods.

<sup>6</sup>For a discussion of variable labor supply, see Walsh (1956), Kemp and Jones (1962), and Martin and Neary (1980).

<sup>7</sup>This latter possibility is made explicit in neo-classical growth models in which capital is one of the productive factors and is currently produced. See Oniki and Uzawa (1965) and the discussion of Findlay (1970) in Section 2.3.

economies.<sup>8</sup> Although the terms of trade (the relative price of exports to imports) are exogenous for such economies, domestic policy can nonetheless influence the level and composition of national income and (if the model is extended to incorporate a monetary sector) the trade balance if it can alter the real exchange rate (defined as the relative price of traded to non-traded goods). Any exogenous shock induces changes in the prices of non-traded goods and these effects are superimposed on the direct effects of the shock itself. For example, Ethier (1972b) and Jones (1977) show that an increase in the price of one traded good relative to other traded goods may lead to a fall in its output in the presence of a non-traded good. Moreover, the induced change in the price of non-traded goods may be in either direction. Consider, for example, the case examined by Jones (1974b) of an increase in the price of importables with the price of exportables held constant. To the extent that substitution effects between importables and non-tradeables are strong, the price of the non-traded good tends to rise, since demand is switched away from imports and resources are bid away by the import-competing sector. But the rise in the price of importables has a negative income effect, and if it dominates, then the demand for the non-traded good falls and its price is likely to fall. Similar conflicts between income and substitution effects due to the presence of non-traded goods arise in the analyses by Burgess (1978) of foreign capital inflows and Corden and Neary (1982) of the "Dutch Disease."

Finally, although the general production framework described above holds for all the models in Sections 2.1–2.4, the response of commodity outputs to commodity prices is smooth and well defined only if the number of primary factors is at least as great as the number of final commodities.<sup>9</sup> If this condition is not met, the production possibilities frontier in output space consists of ruled surfaces, and output levels are indeterminate for price ratios coincident with the slopes of those surfaces.<sup>10</sup> The phenomenon of production indeterminacy is by no means a curiosum – it arises in the Ricardian model, for example – and when it obtains the actual production pattern chosen will be determined by considerations outside the particular model being studied, such as the time path by which the economy approaches its current equilibrium or demand conditions at home and abroad. Alternatively, production indeterminacy may be resolved if some

<sup>8</sup>The implications of non-traded goods for trade models have been considered by McDougall (1965), Komiya (1967), Ethier (1972b) and Jones (1974b). Their application to macroeconomic policy has been considered by many writers, including Salter (1959), Pearce (1961), Dornbusch (1974), Jones and Corden (1976), Helpman (1977), Noman and Jones (1979), Neary (1980c) and Neary and Purvis (1982).

<sup>9</sup>In models with joint production, the relevant comparison is between the number of primary factors and the number of productive *activities*, as Woodland (1977b) has pointed out. We return to this issue in Section 2.5 below.

<sup>10</sup>The consequences of more commodities than factors being produced were first noted by Samuelson (1953). Melvin (1968) studies the two-factor, three-commodity case in detail and Chang (1979) presents a comprehensive analysis of the general case.

goods are not traded on world markets so that their equilibrium prices are determined by the interaction of domestic supply and demand.

### 2.1. The exchange model

Many questions in trade theory involve the behavior of demand in a crucial way. To study these questions it proves useful to strip the production side of the model to a bare minimum. The resulting model, often referred to as the “exchange model,” is here envisaged as a two-sector model in which each product is produced with a single factor specific to that sector and exogenously given in supply. The very sparseness of the production structure—outputs do not respond to price changes—makes the exchange model an ideal vehicle for studying problems in which demand behavior is important.

The first such problem is the question of stability of equilibrium. Given the non-negative relationship between prices and outputs noted earlier, production response always enhances stability. Hence the exchange model isolates the potential source of instability, namely, asymmetric income effects in demand. Of course this role of income effects has been well-known at least since Hicks (1939) but it tends to be obscured by the usual presentation of the Marshall–Lerner condition for stability.<sup>11</sup> Only when the elasticities in this condition are decomposed into income and substitution effects does it become clear that no threat to stability arises unless each country has a higher marginal propensity to consume its own export good; in that case, the income effect of a rise in the relative price of the home country’s export good, which raises real income at home and lowers it abroad, tends to *increase* the world excess demand for the home country’s export good. (Note an immediate implication: the Marshall–Lerner condition must be satisfied if tastes are the same in both countries.)

A second problem for which the exchange model is especially appropriate is the effect of international goods transfers on the equilibrium terms of trade. Since the answer to this question is found by examining the sign of world excess demand for either good at the initial terms of trade, it is perfectly legitimate in many circumstances to consider the issue in the exchange model because even when production is variable it does not actually change until after the terms of trade alter. It is this consideration which leads to the important result of Samuelson (1952) that the direction of change in the terms of trade depends solely on income

<sup>11</sup>The Marshall–Lerner condition referred to in the text is that the sum of the elasticities of the offer curves of the two countries (i.e. their general-equilibrium import demand elasticities) should exceed unity. This should be distinguished from the special case (corresponding to infinite supply elasticities in both countries) of the partial-equilibrium Bickerdike–Robinson–Metzler condition. Jones (1974b) and Dornbusch (1975) investigate the circumstances in which the latter may be given a general-equilibrium interpretation. The decomposition of the offer curve elasticity into income and substitution effects is given in Jones (1961a).

effects: specifically, in a two-country two-commodity free-trade world, the terms of trade of the donor country will worsen if and only if it has a higher marginal propensity to consume its own export good than has the recipient country. In such a case the transfer leads, at initial prices, to a net decline in world demand for the donor's exports, which must give rise to a worsening of its terms of trade. (Note that this criterion is exactly the same as that given above for the income effects of a change in the terms of trade to be destabilizing.)

Samuelson concluded from this result that no presumption could be established in favor of what he called the "orthodox" view that a donor country would suffer a "secondary burden" of a decline in its terms of trade (over and above the primary burden occasioned by the direct loss of purchasing power arising from the transfer itself).<sup>12</sup> This conclusion derives from the fact that economic theory places no restrictions on marginal propensities to consume, other than that they must lie between zero and one in the absence of inferior goods. However, as Jones (1970a) has pointed out, the marginal propensities to consume in question are for the good *exported* by the donor country and we would not in general expect taste differences between countries to be unrelated to trade patterns. On the contrary, the country with the larger marginal propensity to consume a given commodity is likely to be the country which *imports* that commodity. In a pure exchange model with equal initial endowments, this must be the outcome if marginal and average propensities are positively correlated. This line of reasoning therefore suggests an anti-orthodox presumption that the transfer is likely to raise world demand for the donor's exports, and so to improve its terms of trade.

While much can be said about the transfer problem using the exchange model, it cannot deal with situations where the transfer induces changes in production *before* the terms of trade alter. One obvious illustration of this is when the transfer is effected by means of productive factors rather than final goods. Another is when the transfer is effected via final goods, but either country also produces a non-traded good.<sup>13</sup> The issue of production changes is also relevant to the effects of a transfer on the real incomes of the countries involved. For example, if the anti-orthodox outcome ensues, can the secondary benefit arising from the improvement in the donor's terms of trade be so great as actually to raise its real income? In a two-country exchange model this paradox is impossible: the improvement in the donor's terms of trade just sufficient to keep the real income

<sup>12</sup> However, in a later paper [Samuelson (1954)] he showed that artificial impediments to trade (including tariffs though excluding transport costs which reflect the fact that international transportation consumes real resources) go some way towards salvaging the orthodox view.

<sup>13</sup> The transfer problem in the context of non-traded goods has been considered by Johnson (1956), McDougall (1965), Samuelson (1971a), Chipman (1974) and Jones (1975a). Samuelson considered the case where the non-traded commodity is leisure rather than a final good, but from a formal point of view the issues raised in the two cases are the same.

of both countries constant gives rise to substitution effects which raise world demand for the donor's import good. Hence the actual change in the equilibrium terms of trade must be *less* than that sufficient to redistribute world real income towards the donor.<sup>14</sup> However, if the transfer leads to output changes of tradables at the initial terms of trade, this argument need not hold. Moreover, even remaining within the confines of the exchange model, it has recently been shown that the donor may gain if there is a third country engaged in trade, even if it is not a party to the transfer. The presence of the third country does not alter the Samuelsonian criterion for the direction of change in the terms of trade (since, at initial prices, the third country is unaffected by the transaction). However, if the terms of trade improve for the donor and taste patterns differ between the third country and the recipient (with the taste bias in the third country towards its export good), the redistribution of world income may encourage such a rise in the donor's export price that its real income rises.<sup>15</sup>

Moving on from the transfer problem we come next to the theory of tariffs, where once again the exchange model is the ideal vehicle for studying the qualitative effects on the international equilibrium of changes in tariff rates on final goods, since any induced production response would merely enhance the substitution effects in demand of price changes. While much of tariff theory is concerned with normative questions, we may mention one important positive issue with which it deals, namely, the effects of a tariff on world and domestic prices. The "normal" outcome in this case is that a tariff raises the domestic relative price of the home country's import good and lowers its relative price on world markets. In other words, the tariff is "protective" in that it encourages increased domestic production in the import-competing sector, while at the same time it improves the home country's terms of trade. However, either of these normal outcomes can be reversed if either country's demand for imports is price-inelastic, requiring a large change in prices to restore world markets to equilibrium. Thus, if home demand is highly inelastic and all the proceeds of the tariff revenue are spent on imports, the resulting increase in import demand may be sufficient to *worsen* the home country's terms of trade. Alternatively, if foreign demand is highly inelastic and all the tariff revenue is spent on exports, the terms of trade may improve to such an extent that the domestic relative price of imports

<sup>14</sup>This argument is presented in Caves and Jones (1981, pp. 64–65).

<sup>15</sup>This result was demonstrated in a numerical example by Gale (1974), although the logic of the argument for both donors and recipients was earlier discussed in Johnson (1960), and criteria in the Johnson framework derived by Komiya and Shizuki (1967). General criteria for this and related three-agent transfer paradoxes were derived by Yano (1981), who shows that they are consistent with Walrasian stability and with some degree of substitutability in demand. Some of these results were independently obtained by Chichilnisky (1980) and Brecher and Bhagwati (1981) in two-country models where one country consists of two groups with different taste patterns.

falls.<sup>16</sup> The first of these paradoxes admittedly requires some degree of asymmetry in the disposition of the tariff revenue: a deterioration in the terms of trade is impossible in a two-commodity model if tariff revenue is returned to the private sector in a lump-sum manner. However, the possibility of the tariff's being anti-protective survives the relaxation of this and other assumptions, requiring only that the foreign elasticity of demand for imports be less than the home marginal propensity to consume exportables.<sup>17</sup>

Finally, although the exchange model is a crude vehicle for considering questions of domestic income distribution, it permits an examination of the effects of exogenous shocks on the distribution of real income between countries. While this issue is closer to the concerns of normative theory, we mention one aspect which links with our earlier emphasis on the importance of import demand elasticities: namely the phenomenon of "immiserizing growth," first pointed out by Edgeworth (1894) and independently rediscovered by Johnson (1953, 1955) and further discussed by Bhagwati (1958). As with an international transfer, growth imposes a "secondary burden" on the growing country if it raises the excess demand for imports at the initial terms of trade. However, with no matching change in supply abroad, the resulting deterioration in the terms of trade can be significant enough to leave the growing country worse off as a result of growth, provided the elasticity of the rest of the world's demand for imports is sufficiently low.

## 2.2. *The Ricardian model*

In turning from the exchange model to the Ricardian model, the focus moves towards a model which predicts extreme shifts in production patterns when trade is opened up. The two models are polar opposites because the exchange model excludes completely the possibility of resource transfer, whereas the Ricardian model permits the maximum degree of internal factor mobility. Moreover, whereas the exchange model pins down the quantities of different goods which are available for trade, the Ricardian model pins down relative prices (at least, before trade is opened up) by its assumptions that production costs are independent of the level of output and that techniques of production are independent of factor prices and the composition of output. This makes it an extremely useful model for isolating the effects of intercountry differences in technology or in scale (where the latter are not confused with the effects of differences in the degree of scale,

<sup>16</sup>Both of these outcomes are illustrated in Figure 4 of Lerner (1936) although the second case was examined in greater depth by Metzler (1949) and has come to be associated with his name. The possibility of this "Metzler paradox" was disputed by Sodersten and Vind (1968), but their analysis was corrected by Jones (1969).

<sup>17</sup>Komiya (1967) and Jones (1974a) extend the Metzler paradox to models with intermediate and non-traded goods.

which we consider in Section 4.2 below). At the same time, the Ricardian model throws no light on questions related to the internal distribution of income, since it assumes either a single mobile factor or many mobile factors which are used in equal proportions in all sectors (so that they may be aggregated into a single Leontief composite factor).

Although mainly used by Ricardo to demonstrate the gains from trade, the major interest of this model stems from its positive application in providing a theory of trade and production patterns. The reasoning leading to this theory in the two-country, two-commodity case is straightforward. Since each sector uses a single factor, competition ensures that output prices are directly linked to wage rates: e.g. in the home country  $p_j$  equals  $a_{Lj}w$  (where commodities are indexed by  $j = 1, 2$ , and  $a_{Lj}$  is the labor requirement per unit output in sector  $j$ ). Internal labor mobility ensures that the same wage obtains in each sector, so that if a country produces both goods their relative price must equal the ratio of unit labor coefficients. The home country thus has a lower autarkic relative price of good 1, and so a comparative advantage in producing that good, if and only if:

$$\frac{a_{L1}}{a_{L2}} < \frac{a_{L1}^*}{a_{L2}^*}, \quad (2.1)$$

where an asterisk denotes variables relating to the foreign country. When barriers to trade are eliminated, competition therefore forces at least one country to specialize in the production of the commodity which it produces relatively more efficiently and trade patterns completely reflect comparative advantage.

The Ricardian model isolates differences in technology as the basis for trade, but it does not rule out a role for demands. For example, of the four possible equilibria in which at least one country specializes in production, the principle of comparative costs rules out only one: the inefficient case where both countries specialize according to comparative *disadvantage*. Depending on demand conditions, a free-trade equilibrium may occur at any of the other three points of complete specialization, or at intermediate points where one or the other country produces both goods.<sup>18</sup> Moreover, demand takes on a special role if equilibrium occurs at the point where countries specialize completely according to comparative advantage, since the equilibrium relative price ratio is then only bounded by relative production costs.<sup>19</sup> Finally, although it is comparative rather than abso-

<sup>18</sup>This argument may be illustrated using the world efficiency frontier, introduced by Whitin (1953). McKenzie (1954) showed that, irrespective of the number of countries and commodities, this frontier is defined by the set of linear combinations of all efficient specialization patterns.

<sup>19</sup>Graham (1923) was highly critical of Mill (1848) for focusing on such “limbo” price ratios, and argued that with many commodities and countries such outcomes were highly unlikely. However, the work of McKenzie and others has shown that there is no general presumption as to whether equilibrium will occur on a “flat” or at a corner of the world efficiency frontier.

lute advantage which determines efficient patterns of trade and specialization, there is still a role for absolute advantage in determining relative wage rates (or the "double-factoral" terms of trade). Since the price of any good cannot exceed its unit cost, whether the good is produced or not, it is easily shown that relative wage rates are bounded by the ratios of labor productivities for each commodity in the two countries, implying that:

$$\frac{a_{L1}^*}{a_{L2}} \geq \frac{w}{w^*} \geq \frac{a_{L2}^*}{a_{L1}} \quad (2.2)$$

with the wage ratio taking on its upper bound (where all the gains from trade accrue to the home country) when both countries produce good 1 and conversely when both produce good 2.

One of the attractive features of the Ricardian model is that its relatively simple production structure allows virtually all the results we have stated to be extended to many countries and many commodities. Some new features also emerge in higher dimensions. For example, with many commodities but only two countries, commodities can be ranked by comparative costs in a "chain" of decreasing relative labor costs:

$$\frac{a_{L1}^*}{a_{L1}} > \frac{a_{L2}^*}{a_{L2}} > \dots > \frac{a_{Lj}^*}{a_{Lj}} > \dots > \frac{a_{Ln}^*}{a_{Ln}}. \quad (2.3)$$

Demand conditions determine where the chain is broken, but the immutable cost ratios ensure that the home country must export all commodities to the left of the break and import all those to the right, with at most one commodity produced in common. When more than two countries are considered explicitly, no such neat criterion is available. Obviously, an efficient pattern of specialization must satisfy bilateral comparisons such as (2.1) for all possible pairings of commodities and countries. However, as McKenzie (1954) and Jones (1961b) have shown, this requirement is not sufficient to exclude inefficient production patterns. Regardless of the number of countries or commodities, a general criterion for efficient specialization is available which is the appropriate generalization of (2.1): the product of labor requirements in the efficient assignment of commodities to countries must be less than the corresponding product in all other possible assignments that allot the same number of countries to each commodity as does the efficient assignment.

More recently, Dornbusch, Fischer and Samuelson (1977) have shown how a two-country Ricardian model with an infinite number of commodities can be analyzed using elementary geometry and calculus. The key to this simplicity is the assumption that the ratio of unit labor requirements in the two countries varies

continuously between commodities: i.e. if commodities are indexed by  $z$ , the ratio  $a^*(z)/a(z)$  is a continuous and monotonically decreasing function of  $z$ . This function is thus the continuous analogue of the discrete chain (2.3), and the point at which it is broken by demand determines not only the pattern of trade but also, by extension of the reasoning which led to (2.2), the equilibrium double-factoral terms of trade. An additional strategic assumption is that demands take the Mill-Graham form (i.e. preferences can be represented by a monotonic transformation of a Cobb-Douglas utility function) with identical tastes in the two countries. This makes the fraction of world income spent on home-produced commodities an increasing function of the index of the borderline commodity,  $\bar{z}$ , and so the double-factoral terms of trade consistent with balanced trade is also increasing in  $\bar{z}$ . (The higher is  $\bar{z}$ , the greater the share of world income spent on the home country's goods and so the higher, relatively, must be the home wage.) Combining these two functions therefore provides a simple illustration of how the unique equilibrium value of the borderline commodity is determined, and a number of useful comparative statics results are easily derived by considering how various changes shift either of the curves.<sup>20</sup>

The tractability of the continuum model has led to its extension in a number of directions. Samuelson (1982) shows that the model easily accommodates general homothetic tastes which are the same in the two countries: the value of  $w/w^*$  consistent with balanced trade need no longer be an increasing function of  $z$  but it can never decrease at a faster rate than  $a^*(z)/a(z)$ . Hence equilibrium is still unique and most of the earlier comparative-statics results continue to hold. A more extensive generalization has been carried out by Wilson (1980) who allows for non-homothetic and non-uniform demands and an arbitrarily large (though finite) number of countries. Simple diagrammatic analysis is no longer possible: equilibria need not be unique nor is it true that each country produces only those commodities which lie along a single interval. However, Wilson simplifies the model considerably by expressing the demand for each country's products in terms of the derived demand for its labor and thus effectively reduces the model to a many-country exchange model where each country supplies only one good (i.e. its own labor). To deduce the consequences of any parameter change it is thus sufficient to consider in the first instance its effects on the equilibrium wage rate in each country, from which the implications for production and trade patterns can be inferred.

<sup>20</sup>Trade theory is sometimes criticized for neglecting transport costs (although it is unlikely that very much of substance hinges on this, and, in any case, they are just as important in domestic as in international trade). The continuum model lends itself well to their inclusion, for it permits small changes in demands or costs to alter endogenously the range of goods that are exported, not traded internationally, or imported. Similar results have been obtained in a simulation analysis of Heckscher-Ohlin-type models by Helpman (1976).

While the continuum approach clearly permits a tractable analysis of some issues, there remain a number of questions which it is not well-suited to answer. One of these concerns the effects of technological progress in a single sector.<sup>21</sup> This issue was first examined in a Ricardian model by Hicks (1953), who introduced the important distinction between “export-biased” and “import-biased” improvements in technology. The former lowers costs in export industries, so worsening the growing country’s terms of trade and benefitting the rest of the world, whereas the latter has exactly opposite effects.<sup>22</sup> Jones (1979a) considers this question further, noting that the Ricardian model with a finite number of commodities is a convenient framework within which to isolate conditions which give rise to either of the two possible extreme outcomes: immiserization for the growing or the lagging country. This is so because in this model growth in one sector changes at most two relative prices: that of the growing sector’s output relative to other home-produced commodities, and the double-factoral terms of trade which determine the relative price levels of commodities produced in the two countries.

### *2.3. The Heckscher–Ohlin model*

While the Ricardian model isolates differences in technology between countries as the basis for trade, the Heckscher–Ohlin model focuses instead on differences between countries in their relative factor endowments and on differences between commodities in the intensities with which they use these factors. Costs of production thus become endogenous and, in general, will differ between countries in autarky, even when all have access to the same technology for producing each good. This model therefore provides an alternative explanation of trading patterns and an explicit basis for conflict in internal income distribution.

Largely due to the work of Samuelson, this model dominated international trade theory for much of the post-war period, and its four main properties or “core propositions” came to be viewed as “the central body of international trade theory.” [See Chang, Ethier and Kemp (1980).] We begin by stating these propositions for the standard (minimal-sized) case of two commodities using two internally mobile productive factors.<sup>23</sup>

<sup>21</sup>Dornbusch, Fischer and Samuelson, Wilson, and Krugman (1982), consider the effects in the continuum model of technological progress which takes the form of either a uniform improvement in all sectors in a given country or a convergence between the  $a(z)$  schedules of two countries (which may be viewed as reflecting the international diffusion of technological knowledge).

<sup>22</sup>Although Hicks explicitly used a Ricardian model, he did not specify the structure of trade and production in great detail, and most later formalizations of his approach adopted a Heckscher–Ohlin framework. (See footnote 35 below.)

<sup>23</sup>The original sources for these propositions are: Lerner (1952) and Samuelson (1948, 1949) for the factor-price equalization theorem; Stolper and Samuelson (1941) for the Stolper–Samuelson theorem;

(1) *Factor-price equalization theorem.* In its global form, this theorem states that, under certain conditions, free trade in final goods alone brings about complete international equalization of factor prices. In its local form, the theorem asserts that, at constant commodity prices, a small change in a country's factor endowments does not affect factor prices.

(2) *Stolper–Samuelson theorem.* An increase in the relative price of one commodity raises the real return of the factor used intensively in producing that commodity and lowers the real return of the other factor.

(3) *Rybczynski theorem.* If commodity prices are held fixed, an increase in the endowment of one factor causes a more than proportionate increase in the output of the commodity which uses that factor relatively intensively and an absolute decline in the output of the other commodity.

(4) *Heckscher–Ohlin theorem.* A country has a production bias towards, and hence tends to export, the commodity which uses intensively the factor with which it is relatively well endowed.

To illustrate these propositions, we turn first to the model's implications for the distribution of income, which are easily seen with the help of the unit cost curves,  $c_1$  and  $c_2$ , in Figure 2.1.<sup>24</sup> Each curve shows the combinations of the wage rate  $w$  and the rental rate  $r$  which imply a unit cost of production equal to the output price of the sector in question. The coordinates of point  $A$  are thus the only values of  $w$  and  $r$  compatible with zero profits in both sectors. Provided such an equilibrium is consistent with the economy's factor endowment, factor prices are thus determined solely by the location of the curves  $c_1$  and  $c_2$ , in other words, by technology and commodity prices. To understand the caveat about consistency with factor endowments we may note that the slope of the unit cost curve always equals the cost-minimizing capital–labor ratio in the sector in question. Moreover, for both factors to be fully employed, the economy's overall capital–labor ratio  $k$  must be a weighted average of the capital–labor ratios used in each sector:

$$k = \lambda_{L1}k_1 + \lambda_{L2}k_2, \quad (2.4)$$

where the weights,  $\lambda_{Lj}$ , denote the proportion of the total labor force employed in

Rybczynski (1955) for the Rybczynski theorem; and Heckscher (1919) and Ohlin (1933) for the Heckscher–Ohlin theorem. The term “core propositions” was introduced by Ethier (1974) who also presents a vigorous defense of their robustness.

<sup>24</sup>These curves were introduced by Samuelson (1962) and have been applied to trade problems by a number of authors, including Schweinberger (1975), Burgess (1976), Woodland (1977a) and Mussa (1979), their increased use [along with that of the national product function] reflecting the recent drift from primal towards dual techniques. For an economy with more than one sector, we prefer the term “unit cost curve” to “factor price frontier”, since the latter usually refers to the locus of efficient factor prices for the economy as a whole. In Figure 2.1 the factor price frontier is the outer envelope of the individual sectors' unit cost curves (illustrated by a heavy line). Another popular diagram used to illustrate properties of the Heckscher–Ohlin model is known as the Harrod–Johnson diagram. See Harrod (1958), Johnson (1957), and earlier use by Samuelson (1949).

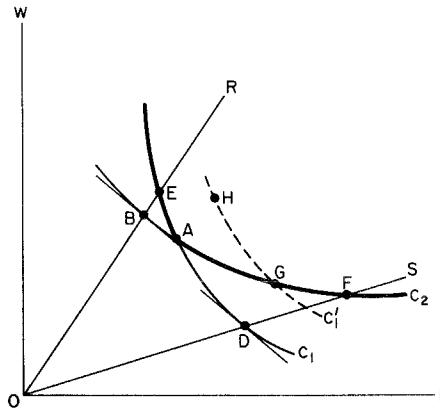


Figure 2.1. Unit cost curves.

sector  $j$ . Hence, joining the origin  $O$  to the points  $B$  and  $D$  at which each sector's capital-labor ratio equals the endowment ratio gives rise to the cone  $ROS$ , which we may call a "cone of diversification."<sup>25</sup> Provided the intersection point  $A$  lies within this cone the economy produces both goods and factor prices are locally independent of endowments.

While the factor-price equalization theorem asserts that factor prices are independent of endowments, the Stolper-Samuelson theorem is concerned with the nature of their dependence on commodity prices. Specifically, it predicts what Jones (1965) has called a "magnification effect": a given proportional change in commodity prices gives rise to a greater proportional change in factor prices, such that one factor price unambiguously rises and the other falls relative to *both* commodity prices. This may be seen in Figure 2.1: the increase in the price of good 1 shifts  $c_1$  to  $c'_1$  and thus lowers the wage rate and raises the rental by a greater proportionate amount than the price increase (since the new equilibrium point  $G$  lies to the right of  $H$  which is on the same ray from the origin as  $A$  and so represents a situation where the relative rental increase just matches the increase in the price of good 1). More formally, the changes in the unit cost and hence in the price of each commodity must be a weighted average of the changes in the two factor prices (where the weights are the distributive shares of the two factors in the sector concerned and a circumflex denotes a proportional change:  $\hat{w} \equiv$

<sup>25</sup>This concept was discussed by McKenzie (1955) in the context of the primal representation of technology whose geometric depiction in the two-sector case was developed by Lerner (1952) and Pearce (1952). See also Chipman (1965–66).

$dw/w)$ :<sup>26</sup>

$$\theta_{L1}\hat{w} + \theta_{K1}\hat{r} = \hat{p}_1, \quad (2.5)$$

$$\theta_{L2}\hat{w} + \theta_{K2}\hat{r} = \hat{p}_2. \quad (2.6)$$

Since each commodity price change is bounded by the changes in both factor prices, the Stolper–Samuelson theorem follows immediately, with its prediction of unambiguously conflicting changes in real factor rewards following a change in commodity prices.<sup>27</sup>

Corresponding to the magnification effect of the Stolper–Samuelson theorem is a similar relationship between endowment changes and output changes implied by the Rybczynski theorem, the duality between the two theorems reflecting the reciprocity relations discussed earlier. An increase in the capital–labor endowment ratio leaves the wage-rental ratio, and hence factor proportions in each sector, unaffected, provided relative commodity prices do not change and both goods continue to be produced. Equation (2.4) therefore implies that the fraction of the labor force employed in the less capital-intensive sector must fall and the fraction in the other sector must rise by a greater relative amount than the endowment change. With a constant capital–labor ratio in each sector, this in turn implies a similar pattern of output changes, which is the essence of the Rybczynski theorem. To see this more formally, we totally differentiate the two full-employment conditions for this model to obtain:

$$\lambda_{L1}\hat{x}_1 + \lambda_{L2}\hat{x}_2 = \hat{L}, \quad (2.7)$$

$$\lambda_{K1}\hat{x}_1 + \lambda_{K2}\hat{x}_2 = \hat{K}. \quad (2.8)$$

In a manner analogous to (2.5) and (2.6), these equations state that endowment changes are bounded by output changes and so the highly asymmetric response to endowment changes predicted by the Rybczynski theorem must apply.

The final core proposition is the Heckscher–Ohlin theorem itself, but this in fact is closely related to the Rybczynski theorem. Consider two countries with different relative factor endowments and the same technology for producing both

<sup>26</sup>These equations follow from totally differentiating the competitive profit conditions and invoking the envelope property of the unit cost function. Our algebraic development of this model follows the approach of Jones (1965).

<sup>27</sup>A stronger form of the Stolper–Samuelson theorem (as it was presented by its originators) is that protection must raise the real return to the factor used intensively in the import-competing sector. This requires the additional assumption that protection raises the domestic relative price of the import-competing good; in other words, that the conditions for the Metzler paradox outlined in Section 2.1 do not hold.

goods. If both countries face the same commodity prices then, by the Rybczynski theorem, the country with the greater relative endowment of capital will produce relatively more of the capital-intensive good. This may be seen by subtracting (2.8) from (2.7) to obtain:<sup>28</sup>

$$\hat{x}_1 - \hat{x}_2 = \frac{1}{|\lambda|} (\hat{L} - \hat{K}), \quad (2.9)$$

where  $|\lambda|$  equals  $(\lambda_{L1} - \lambda_{K1})$ . Provided this production bias is not offset by a demand bias, the relatively capital-abundant country will export the relatively capital-intensive good. When it is expressed in terms of a physical definition of factor abundance, the Heckscher–Ohlin theorem is thus a simple corollary of the Rybczynski theorem, and no consideration of autarky production patterns is required. Alternatively, the concept of factor abundance may be formulated in terms of relative factor prices before trade takes place. When expressed in this way, the Heckscher–Ohlin theorem requires in addition that the relationship between relative commodity and factor prices predicted by the Stolper–Samuelson theorem hold. From equations (2.5) and (2.6):

$$\hat{w} - \hat{r} = \frac{1}{|\theta|} (\hat{p}_1 - \hat{p}_2), \quad (2.10)$$

where  $|\theta|$ , equal to  $(\theta_{L1} - \theta_{L2})$ , has the same sign as  $|\lambda|$  in (2.9).<sup>29</sup> In the absence of trade, the relative scarcity of the labor-intensive good in the capital-abundant country is reflected in its relative price being higher than abroad which, from (2.10), implies that capital will be relatively cheap in the capital-abundant country. Thus relative factor abundance in either the physical or the value sense is the source of comparative advantage in this model.

This prediction about trade patterns is one of the central features of the Heckscher–Ohlin model and it has inspired extensive empirical testing, beginning with the famous study of U.S. trade patterns by Leontief (1953). We leave further consideration of these and other empirical matters to Chapter 10 below and concentrate here on some theoretical issues which have arisen in the process of extending the Heckscher–Ohlin model. One of these is the question of whether, when the number of commodities is increased but the number of factors and countries remains equal to two, it is possible to construct a “chain” of compara-

<sup>28</sup>The term  $|\lambda|$  is the determinant of the matrix of factor-to-sector allocations,  $\lambda_{ij}$ , and is positive if and only if sector 1 is relatively labor-intensive (in the sense of having a lower capital–labor ratio than sector 2, i.e.  $k_1 < k_2$ ).

<sup>29</sup> $|\theta|$  is the determinant of the matrix of factor shares and is positive if and only if sector 1 is relatively labor-intensive (in the sense that wages constitute a larger proportion of the value of its output than in sector 2).

tive advantage, similar to that which holds in the Ricardian model [eq. (2.3) above] but in terms of factor intensities rather than relative labor productivities.<sup>30</sup> Jones (1956) argued that ranking commodities by their capital-labor ratios (assuming that factor-intensity reversals do not take place) does indeed yield such a chain, with all commodities having capital-intensities higher than a certain level being exported by the more capital-abundant country and all others being imported; the location of the cut-off point in the chain is determined (as in the Ricardian model) by demand and by the relative sizes of the two countries. The validity of this proposition has been demonstrated explicitly by Deardorff (1979): provided factor prices in the two countries continue to differ after trade takes place, the capital-abundant country must have the higher wage-rental ratio and hence must specialize in and export the more capital-intensive goods (with at most one commodity being produced in common by both countries). However, the proviso that trade does not equalize factor prices is crucial here, as Melvin (1968) and Bhagwati (1972) have pointed out.<sup>31</sup> If factor prices are equalized by trade then the pattern of production in each country and hence the pattern of trade is indeterminate and so the “chain” proposition need not hold in general.<sup>32</sup>

As we would expect, when we consider a small country for which relative commodity prices are fixed, the case where many commodities are produced with only two factors is straightforward. As shown by Jones (1974c), such a country will locate along the “chain” at a point determined by its factor endowment, producing only those goods (one or two) whose factor intensities are “close” to its own endowment ratio. Even if technology is the same at home as in another similar small country, factor prices are unlikely to be equalized internationally in such a world since the mix of commodities produced is likely to differ between the two countries unless they have very “similar” endowments. Nevertheless, trade patterns in this world reflect the Heckscher–Ohlin theorem in the modified sense that the factor intensities of the small country’s exports mirror its endowment ratio, while it imports goods which are both more and less capital-intensive than those it produces.

<sup>30</sup>We confine attention here to the case where the number of commodities is finite and so the “chain” is a discrete one. However, as with the Ricardian model, it is possible to assume instead that the number of commodities is infinite, with the capital–labor ratio of each commodity varying along a continuum. Such a model has been analyzed in detail by Dornbusch, Fischer and Samuelson (1980), although the pay-off to this extension is not as great as in the Ricardian case, since the discrete Heckscher–Ohlin model already allows considerable scope for substitution between factors.

<sup>31</sup>Travis (1964, ch. 2) and Dixit and Norman (1980, pp. 114–121) give a useful diagrammatic technique for determining which allocations of a given world factor endowment are consistent with factor-price equalization when there are two factors and three goods.

<sup>32</sup>In this case, both countries produce along the same ruled surface of their production possibility frontiers (except for differences in scale) and both produce strictly positive amounts of all goods (apart from boundary cases). (Recall our earlier discussion of ruled surfaces and the references given there.) An open question for research is whether the implied trade patterns conform with the predictions of the Heckscher–Ohlin theorem if the production indeterminacy is resolved by specifying an explicit dynamic adjustment mechanism for the transition from autarky to free trade.

The low dimensionality of the simple Heckscher–Ohlin model has attracted much attention and will be considered further in Section 2.5 and in Chapters 3 and 10. By contrast, a limitation of the model which is at least equally significant but has received rather less attention is its view of factor endowments as an exogenous determinant of trade patterns. In fact, endowments may not be “primitive” in this sense, but can be influenced by trade, both instantaneously (as when trade affects the choice between work and leisure) and over time (through changes in the rate of capital accumulation). Most attempts to examine the latter issue have considered open-economy extensions of the two-sector growth model of Uzawa (1961) in which the capital good is internationally traded. By contrast, Findlay (1970) presents a model which is closer in spirit to the Heckscher–Ohlin approach in that both traded goods are used for final consumption while additions to the capital stock are produced by a third, non-traded goods, sector.<sup>33</sup> The results he obtains are recognizably Heckscher–Ohlin in spirit but relate not to the effects of changes in endowments but of changes in the genuinely exogenous parameters of his model, the rates of population growth and of savings. A rise in the former lowers the economy’s steady-state capital–labor ratio which (in a manner similar to that of the Rybczynski effect) lowers the relative quantity of the capital-intensive good produced. By contrast, a rise in the savings rate may raise or lower the relative output of the capital-intensive good in the short run, but must raise it in the long run. At least in this model, therefore, the spirit of the Heckscher–Ohlin theorem is preserved provided factor abundance is interpreted not in terms of exogenous physical endowments but of the rate of labor force growth and the propensity to accumulate capital.<sup>34</sup>

In conclusion, the relatively rich production structure of the Heckscher–Ohlin model has made it a source of fruitful hypotheses for empirical testing (whose usefulness is not diminished by the fact that in its simplest form – two goods, two factors and identical technology worldwide – the model’s predictions are overwhelmingly rejected by the data) as well as a useful vehicle for the study of a wide range of theoretical issues.<sup>35</sup> Nevertheless, the very starkness of its predictions, and in particular its rigid linking of factor prices to commodity prices, has led

<sup>33</sup>With only two factors perfectly mobile between all three sectors, the fixity of traded goods prices pins down the price of the non-traded good as well as domestic factor prices, exactly as in the static models of Komiya (1967) and Ethier (1972b). A model with an identical formal structure has been used by Samuelson (1965) to demonstrate that free trade equalizes not only the rental on capital but also the real interest rate between countries, since the latter equals (in equilibrium) the rental divided by the price of (non-traded) machines. The properties of all these models are extremely sensitive to the assumption that both traded goods continue to be produced, and, as Ethier points out, this is more stringent than requiring non-specialization in an otherwise identical model with no non-traded goods. Deardorff (1974) shows that the production sector of Findlay’s model becomes identical to that of Uzawa’s closed-economy growth model if only one traded good is produced.

<sup>34</sup>For a related analysis, see Deardorff and Hanson (1978).

<sup>35</sup>To take just one example of the latter, the analysis of the post-World War II “dollar shortage” by Hicks (1953), mentioned in Section 2.2, suggested that technological progress in a country’s export

many economists to question its generality. Partly for this reason, trade theory has recently seen a revival of interest in an older model, which abandons the assumption of complete intersectoral mobility of all factors and assumes instead that some are specific to particular sectors.

#### 2.4. The specific-factors model

This model has its antecedents in the work of Cairnes and Bastable, and was used explicitly or otherwise in inter-war writings by Haberler and others who attempted to break out of the Ricardian straitjacket of constant costs. However, it was eclipsed by the rise of the Heckscher–Ohlin model and recent interest in it dates only from the work of Jones (1971c) and Samuelson (1971c).<sup>36</sup>

In its simplest two-sector form, the assumptions of this model differ from the basic Heckscher–Ohlin model in only one respect: only one factor is assumed to be intersectorally mobile. Nevertheless, the properties of this model contrast strongly with those of the Heckscher–Ohlin model. To illustrate these, we invoke Figure 2.2.<sup>37</sup> In the left-hand panel the horizontal axis measures the economy's labor force and, for given commodity prices, each sector's labor demand curve is drawn with respect to the appropriate origin ( $O_1$  or  $O_2$ ) as a downward-sloping function of the wage rate, the diminishing returns to labor reflecting the presence of a specific factor in each sector. The initial equilibrium wage rate,  $w_0$ , is thus determined at the point of intersection of the two curves,  $A$ , and since constant returns to scale prevail in each sector the returns to the specific factors may be read off the unit cost curves in the right-hand panel. These curves are identical to those introduced in Section 2.3 but the interpretation of the horizontal axis is very different: the stocks of "capital" in each sector are now distinct factors and so their returns,  $r_1$  and  $r_2$ , are not commensurable. Although they are set equal to

sector would necessarily worsen the country's terms of trade. However, as Findlay and Grubert (1959) have demonstrated, consideration of this issue in a Heckscher–Ohlin context points up the crucial importance of the factor bias of the technological progress. In particular, if it is biased towards accentuating the difference in factor intensities between the two sectors (for example, if the capital-intensive export sector experiences a labor-saving improvement) the net outcome (at initial commodity prices) may be an *increase* in the output of the (non-progressing) import-competing sector, opening up the possibility of an *improvement* in the terms of trade.

<sup>36</sup> Caves (1960) documents many of the early contributions to what he calls the "neoclassical" model. Samuelson (1971c) suggests the term "Ricardo–Viner" for this model since it extends Ricardo's assumption of diminishing returns in agriculture to all sectors.

<sup>37</sup> Diagrams similar to the left-hand panel of Figure 2.2 were used by Jones (1971c) and Mussa (1974), while Schweinberger (1980) makes extensive use of the unit cost curve diagram in this context, noting that it can easily be harnessed to derive all the properties of the specific-factors model with many commodities. Dixit and Norman (1979, 1980) analyze this model with a different diagram which makes commodity prices endogenous and so is useful for studying trade patterns and the effect of trade on factor prices. Differences between the properties of the Heckscher–Ohlin and specific-factors model additional to those considered here are noted in Neary (1978a, Section 6).

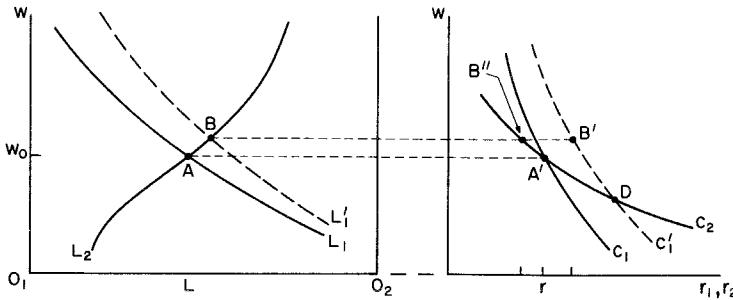


Figure 2.2. Effect of a price increase in the specific-factors model.

one another at the initial equilibrium  $A'$ , this is just an arbitrary normalization and, for the present, has no substantive significance.

Consider first the effects of an increase in the relative price of good 1. Choosing good 2 as numeraire, this causes the labor demand curve for sector 1 in Figure 2.2 to shift upwards by the same proportionate amount as the price increase, from  $L_1$  to  $L'_1$ , giving rise to a new equilibrium at  $B$ . Since employment in the first industry has risen, the output of that sector must also increase. The wage rate must rise but by relatively less than the extent of the price increase. (This is clear from the geometric construction; in economic terms the real wage facing firms in sector 1 must fall if they are to expand output.) Thus there is no magnification effect of prices on wages in this model. By contrast, the returns to both specific factors must change by magnified amounts: the right-hand panel of Figure 2.2 shows that  $r_2$  must fall absolutely (point  $B''$ ) while  $r_1$  rises by more than the increase in  $p_1$  (point  $B'$ ). This outcome is unaffected by the relative factor intensities of the two sectors: as the curves  $c_1$  and  $c_2$  are drawn, sector 2 is relatively labor-intensive (in the sense that the share of wages in the value of its output is greater than that in sector 1:  $\theta_{L1} < \theta_{L2}$ ), but the same conclusion follows if this assumption is reversed.

By comparison with the Heckscher–Ohlin model, therefore, price changes lead to unambiguous changes in the real returns of the two specific factors, but the change in labor's real return cannot be predicted without a knowledge of taste patterns because the wage rate rises in terms of one good and falls in terms of the other. Does this mean that nothing can be said in this model about the Stolper–Samuelson question of the effect of protection on real wages? Ruffin and Jones (1977) have provided a partial resolution of this “neoclassical ambiguity” which applies in all competitive models but takes a particularly simple form in the specific-factors model. Consider the relationship between wage changes and changes in commodity prices and endowments, as derived by Jones (1971c) (we

defer consideration of the expression in parentheses):

$$\hat{w} = \beta_1 \hat{p}_1 - \frac{1}{\gamma} (\hat{L} - \lambda_{L1} \hat{K}_1 - \lambda_{L2} \hat{K}_2). \quad (2.11)$$

The coefficient  $\beta_1$  measures the relative contribution of sector 1 to  $\gamma$ , the economy-wide elasticity of labor demand:

$$\beta_1 = \frac{1}{\gamma} \lambda_{L1} \gamma_1, \quad \gamma \equiv \lambda_{L1} \gamma_1 + \lambda_{L2} \gamma_2, \quad (2.12)$$

where  $\gamma_j$  is the real-wage elasticity of demand for labor in sector  $j$ . At constant endowments, an increase in  $p_1$  raises the wage relative to the numeraire by more, the larger the relative size of the first sector and the more elastic is its demand for labor relative to that of the second sector. However, to the extent that wage earners consume the first commodity, the price increase tends to reduce their welfare. The net effect on the real wage therefore depends on the sign of  $\beta_1 - \alpha_1$ , where  $\alpha_1$  is the share of good 1 in wage-earners' consumption. The Ruffin–Jones argument is that, if wage-earners' tastes are typical of those of the economy as a whole,  $\alpha_1$  equals the share of the first good in aggregate consumption which, since good 1 is the import good, must exceed its share in national production, which we denote by  $\theta_1$ . Without detailed knowledge of the structure of the economy we cannot be sure whether this average production share is greater or less than the marginal response  $\beta_1$ . However, it can be shown that the two are equal if commodity 1 is "unbiased" with respect to labor, in the sense that an increase in  $p_1$  brings about a proportionate increase in the wage equal to the average increase in all factor prices.<sup>38</sup> Thus there is a presumption that protection will reduce real wages in the specific-factors model, although the outcome is not unambiguous. (In the Heckscher–Ohlin model the parameter corresponding to  $\beta_1$  must be either negative or greater than unity, depending on relative factor intensities, and the outcome is thus unambiguous.)

Turning next to changes in factor endowments, their effects on factor prices may be deduced by manipulating Figure 2.2 and are given explicitly by the term in parentheses in equation (2.11). Wages are reduced by growth in the labor force and increased by a rise in the endowment of either specific factor. Exactly the converse is true of the returns to the specific factors. Clearly, with more factors than commodities, international trade does not lead to factor-price equalization in

<sup>38</sup>It can be shown that  $\beta_1 - \theta_1$  is proportional to  $\theta_{L1} \gamma_1 - \theta_{L2} \gamma_2$ . As eq. (2.13) below shows, when this expression is zero, an increase in the economy's labor endowment at constant commodity prices gives rise to "balanced growth" (an equal proportionate expansion of both sectors). A necessary though not sufficient condition for protection to raise real wages in this model is thus that commodity 1 be "biased" towards labor, which implies that the price-elasticity of supply in sector 1 ( $\theta_{L1} \gamma_1$ ) exceeds that in sector 2 ( $\theta_{L2} \gamma_2$ ).

this model even in the local sense. Samuelson (1971c) argued nonetheless that the transition from autarky to free trade would induce partial factor-price equalization in the sense of a reduction in factor-price differences between countries (as Ohlin had originally asserted in his 1933 book). However, this depends both on the commodity relative to which changes in factor prices are measured and, as Dixit and Norman (1979) show, on the nature of endowment differences between countries and technology differences between sectors.

Just as there is no basis for expecting partial, far less complete, factor-price equalization in this model, so the pattern of trade cannot be inferred from a knowledge of factor endowments and factor intensities alone. Nevertheless, both of these elements play a role. This is shown by the expression for the effects on relative outputs of changes in endowments at given commodity prices:<sup>39</sup>

$$\hat{x}_1 - \hat{x}_2 = (\hat{K}_1 - \hat{K}_2) + \frac{1}{\gamma} (\theta_{L1}\gamma_1 - \theta_{L2}\gamma_2)(\hat{L} - \lambda_{L1}\hat{K}_1 - \lambda_{L2}\hat{K}_2). \quad (2.13)$$

The term  $\theta_{Lj}\gamma_j$  is the elasticity of supply of  $x_j$  with respect to  $p_j$  for a given wage. Hence an increase in the labor force lowers the wage rate, from (2.11), which brings about an increase in the output of both goods but a greater increase in the output of the good in more elastic supply. While relative supply elasticities thus play a role similar in this model to the role of relative factor intensities in the Heckscher–Ohlin model, it is also illuminating to consider separately the two components of these elasticities. Thus, if the two industries have equal labor demand elasticities  $\gamma_j$  (or equal elasticities of substitution  $\sigma_j$ ), factor intensities have a similar effect on output patterns as in the Heckscher–Ohlin model: the more labor-intensive sector is encouraged to expand to a greater extent. Elasticities of substitution also matter, however, since they determine the extent to which each sector can increase its labor intensity and so expand output in response to a given fall in wages. Finally, eqs. (2.11) and (2.13) show that increases in the endowments of each of the sector-specific factors have similar effects on wages and hence on relative outputs, but they also have direct effects on outputs and it is easily shown that the latter must dominate. Not surprisingly, the country with the greater endowment of the factor specific to sector  $j$  will, other things equal, have a production bias towards that sector's output, and hence be more likely to export it.

One of the more attractive features of the specific-factors model is that all its properties generalize straightforwardly to the case where the number of sectors is arbitrarily large, each one using a specific factor and drawing on the common

<sup>39</sup>The determinants of comparative advantage in the specific-factors model have been examined by Amano (1977) and Dixit and Norman (1979). The breakdown provided by (2.13) is developed in Jones (1971c).

pool of labor.<sup>40</sup> Many of the responses of the general model exhibit a strong gross substitutability property: for example, a rise in the price of any good raises its output and increases the real return of the corresponding specific factor while lowering the output of all other sectors and the real returns of all other specific factors. Similarly, by reciprocity, an increase in the endowment of any specific factor at constant commodity prices raises the output of the corresponding good and lowers the output of all other goods. As for an increase in the labor force, it raises the output of all goods, with output changes ranked according to the position of each sector in the “chain” of increasing elasticity of supply. These properties make the specific-factors model a useful tool in contexts where a tractable multi-sectoral production model is desired, without the extreme implications for specialization patterns typical of the Ricardian model.<sup>41</sup>

Many other issues have been analyzed in the context of the specific-factors model. As Samuelson (1971b) has noted, it is a fully specified general-equilibrium model but its properties are consistent with a partial-equilibrium analysis of a single sector; for this reason it provides a rationalization for simple economic intuition without the potential for paradox which more complex general-equilibrium models introduce.<sup>42</sup> For example, the concept of a sector’s “profitability” can be identified with the return to its specific factor but cannot be easily interpreted in a competitive model where all factors are intersectorally mobile. This makes it an obvious framework within which to study the phenomenon of the “Dutch Disease”, whereby the profitability of one sector is squeezed as a result of a boom in other traded goods sectors.<sup>43</sup> A very different application of the model has been carried out by Dixit (1980) who reinterprets the two commodities as the same good in two different periods produced with period-specific labor and with capital and a natural resource, both of which are “mobile” between periods as a consequence of the endogeneity of savings and resource-use decisions. By exploiting the analogy between this model’s formal structure and that of the specific-factors model and by making some other strategic simplifications, Dixit succeeds in deriving a number of interesting results concerning the determinants of and the relationship between trade in goods and trade in resources.

<sup>40</sup>The properties of the specific-factors model with many commodities have been investigated by Samuelson (1971c), Mussa (1974), Jones (1975b), Dixit and Norman (1980), and anticipated by Harrod (1958).

<sup>41</sup>See, for example, the application to effective protection by Jones (1975b), discussed in Section 3.1 below.

<sup>42</sup>This argument is developed further in Neary (1978a). Among the issues which were first considered in the more tractable specific-factors framework are the implications of rural–urban migration in response to expected wage differentials [see Harris and Todaro (1970) and Section 3.1 below] and the employment effects of capital subsidies [see Neary 1978c].

<sup>43</sup>As Corden and Neary (1982) show, this squeeze is accentuated if the spending effect of the boom raises profitability in sectors producing non-traded goods. By contrast, the contraction of the non-booming traded goods sector may not take place if all factors are intersectorally mobile.

As we have seen, one of the basic features of the specific-factors model is its demonstration that the returns to factors which are trapped in particular sectors will reflect those sectors' fortunes to a magnified extent. These contrasting shifts in factor rewards suggest a strong incentive for market forces to bypass the barriers which enforce the factor specificity, and, if such barriers can be surmounted with the passage of time, we are led to a reinterpretation of the specific-factors model as a short-run model. The simplest way of modelling this process is to assume that the stocks of capital specific to each sector are not physically distinct factors, but rather are temporarily immobile and gradually move between sectors in response to intersectoral differences in rentals.<sup>44</sup> On this interpretation the specific-factors model depicts the short-run or momentary equilibrium of the Heckscher-Ohlin model, where the latter is assumed to apply to some medium-run horizon over which the economy's stock of capital is fixed in aggregate but perfectly mobile between sectors. Thus, in Figure 2.2, the initial equilibrium represented by  $A$  and  $A'$  is one where capital stocks have had time to adjust such that the same reward  $r$  is earned in both sectors. A disturbance to this equilibrium in the form of a once-and-for-all increase in the relative price of good 1 gives rise in the short run to the new equilibrium represented by  $B$ ,  $B'$  and  $B''$ , as already discussed. However, the resulting rental differential means that this equilibrium cannot persist: as soon as capital mobility becomes possible, capital will be reallocated out of the low-rental sector into sector 1. It is at this point that the relative factor intensities of the two sectors play a role for the first time: the movement of capital out of the relatively labor-intensive sector into the relatively capital-intensive sector leads, at the initial wage rate, to excess supply of labor.<sup>45</sup> Hence the wage rate falls as the capital reallocation process continues, until the new "long-run" equilibrium at  $D$  is attained.

This "short-run capital specificity" assumption provides a convenient link between the specific-factors and Heckscher-Ohlin models, as well as a plausible hypothesis about the medium-run evolution of a competitive economy.<sup>46</sup> In its simplest form, however, it relies on an ad hoc specification of the rate of capital reallocation, which is assumed to respond myopically to current differences in quasi-rents rather than to the difference between the present values of locating a

<sup>44</sup>This model has been examined by Mayer (1974b), Mussa (1974), Jones (1975b), Neary (1978a) and Dixit and Norman (1979). See also Grossman (1981).

<sup>45</sup>The term "factor intensities" should be interpreted here in its "physical" sense, corresponding to the sign of  $|\lambda|$  in eq. (2.9). As noted by Jones (1975b) and Dixit and Norman (1979), it is possible for the relative factor intensities of the two sectors in the "value" sense, corresponding to the sign of  $|\theta|$  in equation (2.10), to be temporarily reversed during the adjustment process. However, this does not affect the attainment of the new long-run equilibrium, which is globally stable provided there are no permanent factor-market distortions (as discussed in Section 4.1 below). [See Jones and Neary (1979).]

<sup>46</sup>Kotlikoff, Leamer and Sachs (1981) extend this model to allow for sluggish international as well as intersectoral capital mobility, and argue that its predictions conform closely to post-World War II patterns of international trade and factor-price differences.

unit of capital in one of the other sectors. These deficiencies have been overcome by Mussa (1978), who models the reallocation process by combining an explicit adjustment-costs technology with the assumption of perfect foresight by capital owners. Mussa shows that the more sophisticated model implies a slower convergence towards long-run equilibrium (because the future diminution of the rental differential is foreseen, reducing the incentive to reallocate), but its positive properties are otherwise identical to those of the simple myopic model, provided there are no fixed costs to capital reallocation. The other assumption of the simple model, that labor is perfectly mobile between sectors, has also been relaxed by Mussa (1982) and Grossman and Shapiro (1982), who show how skill differences can restore some degree of coincidence between the interests of workers and the fortunes of the sector in which they are currently employed. Finally, mention should be made of a different mechanism whereby a specific-factors production structure can be transformed into a Heckscher–Ohlin model. If the specific factors are tradeable, their heterogeneity can be circumvented by exchanging them on world markets. If, in addition, these factors are the only commodities in which trade takes place (i.e. all final goods are non-traded) then the balance-of-trade equilibrium condition combined with the assumption of fixed world prices allows any number of specific factors to be aggregated into a single factor, “foreign exchange.” In this fashion the specific-factors model can be transformed by trade rather than by time into a Heckscher–Ohlin model, as in the analysis of “middle products” by Sanyal and Jones (1982), to be discussed in Section 3.1 below.

## 2.5. *Extensions*

The models presented in previous sections are the basic building blocks of positive international trade theory and much of the theoretical work in the field can be categorized by the manner in which it has attempted to combine or extend them. For example, a number of writers have used elements from different models to throw light on specific issues.<sup>47</sup> Gruen and Corden (1970) graft a single sector producing textiles from labor and specific capital onto a Heckscher–Ohlin model in which land and labor produce wool and grain to illustrate how in a multi-good model a tariff may paradoxically worsen a country’s terms of trade. If wool is the

<sup>47</sup>Of course, the most obvious way of combining models is to examine trade between two countries, each of whose production structures is characterised by a different model. However, this direction of research has not been extensively pursued, since there are rarely persuasive grounds for believing that the differences between two models correspond adequately to the differences between two particular countries. An exception to this general trend is the model of North–South growth and trade of Findlay (1980) which combines a Solow-type full-employment model for the developed country (“North”) with a Lewis-type, labor-surplus capital-good-importing country (“South”) to examine the interactions between growth and the North–South terms of trade. (See Chapter 4 below.)

only export and is land-intensive relative to grain, a uniform tariff at initial terms of trade causes manufacturing to draw labor out of agriculture, leading, via the Rybczynski effect, to an increase in the output of wool, making possible a worsening of the terms of trade. In a very different application, Falvey (1981) superimposes on a standard two-sector Heckscher–Ohlin structure a continuum of sector-specific capital goods, each combining with labor to produce a distinct good within the manufacturing sector. The result is a model which provides an explanation for the phenomenon of “intra-industry trade” without any of the departures from competitive assumptions to be considered in Section 4.3 below.

A different way of extending simple models is to use the insights they yield as a way of understanding and interpreting the properties of more complex models. We have already given one example of this: Wilson’s reduction of a very general Ricardian model with many countries and a continuum of commodities to an exchange model as an intermediate step in analyzing the general model. Another example is the analysis of a two-good, three-mobile-factors model by Jones and Easton (1983), drawing on earlier work by Batra and Casas (1976) and Ruffin (1981). They show that this model combines elements of both the Heckscher–Ohlin and specific-factors models: the factor which is least specific to either sector (the “middle” factor) exhibits many of the properties of the mobile factor in the specific-factors model, the ease of substitutability between it and the other factors being a key determinant of output and factor-price responses. However, since both other factors are also mobile, the relative degree of substitutability between these factors and the difference between the distributive shares of the middle factor in the two sectors are also key characteristics helping to determine how changes in commodity prices affect the distribution of income. Another interpretative link between models has been noted by Jones (1970b, 1980) and Ferguson (1978): if capital is internationally mobile in a Heckscher–Ohlin model, trade patterns are determined primarily by comparative labor costs. If, in addition, technology differs between countries, patterns of trade and international capital flows will reflect comparative as well as absolute advantage; differences in technology play a role similar to the one they play in the simple Ricardian model. (This issue is discussed further in Chapter 5 below.)

While splicing models together or viewing one in the perspective of another constitute important directions for the development of the subject, the task of “extending” trade models has often been interpreted very differently; namely, as examining the robustness of the basic properties of simple models to relaxations of their assumptions. Particular attention has focused on one of the most widely criticized assumptions, their low dimensionality. Since this issue is covered at length in Chapter 3 below, we avoid going into detail here and merely note that at least three different approaches to this problem have been explored.

The first approach has concentrated on the case which is the most obvious generalization of the Heckscher–Ohlin model, the so-called “even” case where the

numbers of goods and factors are equal. A variety of results have been derived, mostly in the form of relatively stringent conditions on the matrix of factor input-output coefficients which are sufficient to yield results such as the “strong” generalization of the Stolper-Samuelson condition: an increase in the relative price of each good raises the real return of one factor and lowers the real returns of all other factors.<sup>48</sup>

A second approach, largely initiated by Ethier (1974), has been to investigate what results may be derived when less severe restrictions are imposed on the technology of the economy. We have already noted some relatively weak but completely general properties which are satisfied by all competitive models. Ethier showed that considerably stronger results can be obtained in the model studied by exponents of the first approach (the generalized even Heckscher-Ohlin model) with no restrictions on the input-output matrix other than that all its elements be strictly positive (i.e. each factor is used to some extent in every sector). For example, a rise in the price of one good must raise the real return of at least one factor and lower the real return of at least one other.<sup>49</sup> Similar results were derived by Diewert and Woodland (1977), Jones and Scheinkman (1977) and Chang (1979) in more general models with any numbers of goods and factors where some of the former may be intermediate goods and some of the latter may be specific to certain sectors. All of these contributions have brought to the fore the significance of the comparison between the number of goods and factors, a model characteristic whose importance was first stressed by Samuelson (1953). The even model, with equal numbers of goods and factors, is the knife-edge dividing line between the case of more commodities than factors (where production indeterminacy must be resolved either by allowing specialization or by introducing considerations extraneous to the production side of the model in order to pin down some outputs) and that of more factors than commodities (where local factor-price equalization does not obtain and so the full-employment and price-equals-cost equations must be solved jointly for the effects of commodity prices on factor prices).<sup>50</sup>

Both of the approaches mentioned so far attempt to “generalize” the Heckscher-Ohlin model in the literal sense of deriving results analogous to those of the two-good two-factor model relating changes in individual endowments and commodity prices to induced changes in individual outputs and factor prices.

<sup>48</sup>See, for example, Chipman (1969), Kemp and Wegge (1969) and Inada (1971).

<sup>49</sup>See also Kemp and Ethier (1976).

<sup>50</sup>As noted by Inada (1971), Rodriguez (1975a) and Neary (1980b), the key distinction of relevance here is not really between goods and factors but between commodities whose prices are exogenous (including traded goods and traded factors) and those whose prices are free to fluctuate. As shown by Neary (1980b) for a given structure of technology, if the number of commodities in the latter category is progressively reduced, the prices of those factors which are still freely variable become progressively less responsive to changes in the endowments of non-traded factors; i.e. the economy moves steadily closer to a closer to a state of local factor-price equalization.

However, it is probably asking too much of general-equilibrium models to provide detailed predictions at such a high level of disaggregation without imposing extremely strong restrictions on the technology. A number of authors have therefore looked for general properties which do not necessarily apply to individual prices or quantities. One example of this approach is the work of Deardorff (1980) and Dixit and Norman (1980) mentioned in Section 1, which shows that the principle of comparative advantage as a basis for trade may be generalized not in terms of individual commodities but in terms of a *correlation* between autarkic price differentials and import volumes. Another example is the suggestion in Jones (1977) that general results may be derived for changes in the output of one good or the real reward of one factor relative to the changes in the average of all other outputs or rewards. This approach, of investigating limited questions in general models rather than the converse, is also pursued in Jones and Scheinkman (1977), Dixit and Norman (1980) and Neary (1979), where it is shown that if the exogenous shocks considered are restricted to those which concern comparisons between *dichotomous* groups of factors and commodities, it is possible to aggregate a general production model to a two-by-two form which exhibits many of the properties of the standard Heckscher–Ohlin model.

One more direction of extending the basic models which belongs in this rather than in subsequent sections concerns another key assumption, namely, the absence of joint production. It is this which gives rise to the phenomenon of magnification effects: irrespective of the detailed structure of production, if each good is produced with more than one factor in a distinct productive process, the price-equals-unit-cost equation for any activity can be totally differentiated as follows:

$$\sum \theta_{ij} \hat{w}_i = \hat{p}_j. \quad (2.14)$$

Since each price change is thus a weighted average of factor price changes, some  $\hat{w}_i$  must always exceed any  $\hat{p}_j$  and so factor  $i$ 's real reward must rise. However, if sector  $j$  produces more than one good, the right-hand side of (2.14) becomes itself a weighted average of the corresponding goods prices, and so magnification effects need not obtain. These considerations led Jones and Scheinkman (1977) to argue that in the presence of joint production the asymmetry between factors and commodities characteristic of the Heckscher–Ohlin model ceases to hold. Of course, it is still possible to interpret the left-hand side of (2.14) (as amended) as a measure of the change in the value of the activity in sector  $j$  and to rank factor-price changes relative to this change, and hence to rank them among themselves. This fact was exploited by Chang, Ethier and Kemp (1981) in a detailed analysis of the two-factor two-good model with joint production. Using

an argument similar to that of Ruffin and Jones (1977) they note that if tastes are uniform and homothetic all that is needed for an increase in the real return of a factor is that its return rise relative to the average of other factors. Under this additional assumption, therefore, magnification effects are not necessary in order to pin down income distribution and so results of a Stolper–Samuelson kind can be derived even in the presence of joint production.

### 3. Multi-level trade

The Classical paradigm of international trade limits contact among countries to the exchange of commodities at the final level. Such a view of the nature of international trade was challenged over fifty years ago by Williams (1929), who stressed the historic importance of international labor and capital mobility in his criticism of the Ricardian view that commodities are internationally mobile and factors are not. In recent years renewed efforts have been made to escape the Classical paradigm by allowing links between countries at various stages of the production process, such as the exchange of intermediate products, the international mobility of capital and labor, or trade in technical knowledge.

In calling this section “multi-level” trade we intend to emphasize that much of this work is concerned with trade at more than one level instead of replacing trade in final goods by (say) trade in primary factors. Of course, the literature on trade theory has investigated topics that go beyond the types of trade we discuss here. In particular, the theory of customs unions and economic integration contemplates not only multi-level trade but the possibility of fiscal and monetary union and the harmonization of tax structures. Many important normative questions concerning the advisability of such regional groupings are not discussed below, but are dealt with in Chapter 2.

#### 3.1. *Trade in intermediates and natural resources*

Once international trade in more than final consumer goods is allowed, basic notions of comparative advantage need to be re-examined. We have already discussed the limitations in a multi-commodity world of comparing autarky prices in two countries to predict item-by-item the pattern of trade; generally only correlations can be made except under additional assumptions. With trade in intermediates allowed, the problems in predicting trade in final goods become even greater. As McKenzie (1954) remarked in one of his classic papers on the Ricardian model, the familiar nineteenth century trade pattern in which Lancashire produced and exported cotton textiles would most probably not have

been observed if England had had to grow its own cotton.<sup>51</sup> We shall have occasion both in this section and in Section 4 to revert to this theme: the pattern of trade in final goods may not be readily deducible from a comparison of pre-trade relative prices in these markets.

### 3.1.1. Effective protection

The past fifteen years have witnessed a flood of literature concerned with one aspect of trade theory when final goods flows are accompanied by trade in intermediates: how do interferences in such trade, especially by the use of tariffs, affect the allocation of resources and the "effective protection" which such a pattern of tariffs provides to various sectors and factors of production? The early literature [e.g. Corden (1966)] held out the hope that a structure of effective protective rates, defined, for the sector producing commodity  $j$ , as

$$v_j \equiv \frac{t_j - \sum_i \theta_{ij} t_i}{1 - \sum_i \theta_{ij}} \quad (3.1)$$

would, more accurately than final nominal tariffs alone, indicate the effect of a tariff structure on outputs. (Here  $t_j$  represents the tariff on final good  $j$ ,  $t_i$  the tariff on imports of intermediate product  $i$ , and  $\theta_{ij}$  the distributive share of intermediate product  $i$  in the  $j$ th sector.) This hope was somewhat dashed even for a model with only two final goods by a counter-example of Ramaswami and Srinivasan (1971). For a given tariff structure they show how, in an economy with one set of factor endowments, outputs and resources are pulled in a direction opposite to that in another economy with a different set of factor endowments.<sup>52</sup>

Subsequent work in the area attempted either to salvage something for the concept of effective protection by imposing strong restrictions on the technology (such as fixed coefficients or separability between primary factors and intermediate products in the production process),<sup>53</sup> or to suggest alternative formulae for effective rates that would indeed predict gross output changes or resource

<sup>51</sup>In Jones (1980) a two-country Ricardian model is illustrated in which one commodity requires an intermediate input and technologies differ between countries. The pattern of trade can be reversed as a result of variations in the price of the traded intermediate.

<sup>52</sup>This counter-example is also discussed in Appendix I of Jones (1971a).

<sup>53</sup>References to the role of separability and the so-called "substitution problem" include Corden (1971), Jones (1971a), Ethier (1972a), Bhagwati and Srinivasan (1973) and Khang (1973).

flows.<sup>54</sup> Furthermore, some models allowed local import-competing production of intermediates, whereas others did not.<sup>55</sup>

No doubt part of the frustration exhibited in this literature stems from the difficulty in multi-commodity models, even without intermediate products, of ranking output responses to correspond precisely with changes in relative prices. As is now clearly understood, one should expect no more of effective rates in a model with intermediate goods than one does of nominal tariff rates in a model without.<sup>56</sup> Nonetheless, two of the models discussed in Section 2 possess sufficient structure to make possible at least some predictions on the basis of effective rates. First, recall our interpretation of the model of exchange in Section 2.1 as a production model in which each sector employs primary factors fixed in total supply to that sector. In addition, let each sector require any number of imported intermediates. Effective tariff rates then accurately signal the changed return to the bundle of primary factors stuck in each sector.

The second model is the many-commodity version of the specific-factors model described in Section 2.4, extended to allow each sector to make use of imported intermediate products not produced locally. [See Jones (1975b).] Suppose there is a small change in the tariff structure. Then, by the competitive profit conditions, the effective rate of protection granted to the  $j$ th sector equals a positive weighted average of the changes in the wage rate and the return to the factor used only in sector  $j$  (where the weights are distributive shares in local value added). Thus, in every sector which receives effective protection to a greater extent than the change in the wage rate, the specific factor gains relative to labor. This result does not require separability or other such constraints on the technology. Without a separability assumption, however, output changes or resource flows are more difficult to pin down than are changes in income distribution, since labor flows are then dependent on the degree of substitutability between labor and all the intermediate products. But if separability is imposed, the change in employment in sector  $j$  is positively related to the extent to which sector  $j$ 's effective rate of protection exceeds the change in the wage rate. Thus in the specific-factors model a ranking of industries by effective rates of protection is not necessarily the same as the ranking by domestic resource (labor) flows resulting from these rates, but it does (in the separable case) provide a ranking which is cut by the change in the

<sup>54</sup> Except in the simplest cases, these formulas require detailed knowledge of elasticities of substitution throughout the system as well as of the tariff structure, thus vitiating their usefulness as predictive devices. See Ethier (1971, 1972a, 1977).

<sup>55</sup> Ethier (1977) is particularly emphatic in arguing that models that do not allow local production of imported intermediates should not be expected in general to have output responses predictable from  $n$  (effective) tariff rates (where  $n$  equals the number of final commodities) when  $n + m$  separate outputs and inputs are involved (where  $m$  equals the number of imported non-locally-produced intermediates).

<sup>56</sup> See the discussion and references in Ethier (1977), probably the most penetrating of the many articles on this subject.

wage rate, with labor flowing from all industries receiving less effective protection than the wage change to all industries receiving more effective protection.

### *3.1.2. The “Austrian” model*

In Section 2 we had occasion to stress the role of differences in supply conditions between countries as determinants of trade patterns in basic models of trade. More recent work on trade in a dynamic context, with special emphasis on the time-phased nature of the production process, suggests that differences in time preference may also affect the pattern of trade. Here we bypass the interesting normative issues that such models pose and instead note some positive questions which arise in a model in which trade takes place in an intermediate good as well as in a final good, the “Austrian” model of trade developed by Findlay (1978b).

The intermediate good in Findlay’s model is “wood,” which, combined with labor, instantaneously produces a consumption good which can be traded. Wood is also traded, but is produced by a point-input, point-output process whereby labor is applied initially and the output of wood grows continuously with the passage of time, the period of production being determined by the rate of interest. The technology whereby wood and the final product are produced implies an inverse relationship between the interest rate and the level of per capita consumption that can be maintained in a steady-state equilibrium. Findlay assumes this relationship to be identical for the two countries. But if rates of time preference differ between countries, so also will autarkic relative prices and thus a basis is established for mutually profitable exchange. In particular, the more “impatient” country exports the final product in exchange for wood, since final output is labor-intensive compared with the intermediate product. The relative price of wood is lower in the country with the lower rate of interest. In Findlay’s model a free-trade equilibrium can be established with incomplete specialization in each country leading to equalization of interest rates and wage rates as in the standard Heckscher–Ohlin case, but without the concept of homogeneous capital and fixed endowments traditionally found in such models. The “Austrian” flavor of the model links the concept of capital to the existence of a traded intermediate good, with the value of the capital stock dependent upon the rate of interest and the pattern of trade determined by differences in taste patterns (time preference) between countries.

### *3.1.3. Middle products*

The phrase “middle products” was used by Sanyal and Jones (1982) to encompass what traditionally are referred to as intermediate goods, goods-in-process, and natural resources which have been extracted and prepared for trade on world markets. The core concept in their model is that of a productive spectrum

whereby, at initial stages, natural resources and raw materials are processed and, in the final stages, goods-in-process and intermediate products are locally assembled for national consumption. International trade, according to this view, takes place in commodities somewhere in the “middle” of this productive spectrum, freeing up a nation’s input requirements in the final stages of production from its output of tradeable middle products at earlier stages.

Such a view of the role of international trade suggests a natural division between that part of the economy which produces commodities (middle products) for the world market (including the local economy), called the Input Tier, and that section of the economy which makes use of internationally traded middle products as inputs along with local resources to produce non-traded goods for final consumption (the Output Tier). Ruled out by assumption in the simple version of this model is the notion that the “middle” stages of the productive spectrum might be “thick” in the sense that tradeable middle products might use other tradeable middle products as inputs. In addition, the production structure in each tier of the economy is assumed to resemble that of the specific-factors model discussed in Section 2.4. Labor is mobile both among sectors in each tier and between tiers. The balance of payments provides an additional link between the two tiers; if the trade account is balanced, the value of total output from the Input Tier of the economy is matched by the value of middle products used as inputs (along with labor) in the Output Tier.

Several types of questions have been raised in the context of this model, and of central concern in each case is the allocation of labor between tiers and the real wage. For example, a transfer payment which gives rise to a trade surplus requires labor to be reallocated to the Input Tier as consumption falls, and this serves unambiguously to reduce the real wage.

If domestic (and world) prices of traded middle products remain constant to the small country, all non-labor inputs in the Output Tier can be aggregated, à la Hicks, into a composite middle product input, which serves to convert the production structure in the Output Tier from an  $(n+1)$ -factor,  $n$ -commodity specific-factors model into a two-factor, many-commodity Heckscher–Ohlin model. We described in Section 2.4 how, with the passage of time, a specific-factors model may converge to a (long-run) Heckscher–Ohlin model as factors lose their occupational specificity. In the middle-products model it is the existence of a world market in which middle products can be exchanged for each other that permits such a conversion.

With prices of all final consumer goods dependent at least in part on local conditions (wage rates) as well as on world prices of middle products, the model seems naturally suited to analyze how consumer price levels in two small open economies might differ in response to a commonly faced change in the world price of a middle product. This question is pursued in Jones and Purvis (1982), who show how standard monetary assumptions appended to a middle-products

model can yield simultaneous determination of wage rates and exchange rates. In particular, even if the rise in the world price of an imported middle product affects the two countries' price levels to the same extent, the more flexible country (in the sense of a greater elasticity of substitution between labor and middle products) can experience an appreciating currency and rising wages vis-à-vis the less flexible country, a result in conflict with standard predictions of the purchasing-power-parity doctrine.

The middle-products model allows countries and sectors to differ in the extent to which local value must be added to transform middle products into final commodities, and much depends upon this comparison. It does not, however, focus upon another question: in a vertical production structure with many stages, which goods-in-process or middle products does a country import and which does it export? Two recent papers have tackled this issue independently and with different models. Sanyal (1980) assumes that in each of two countries a commodity is produced in a *continuum* of stages, with different Ricardian labor-only input structures. Depending upon technological differences and relative country size, a cut-off point will be determined, with one country producing the commodity from raw material stage to some intermediate point, and then exporting this good-in-process to the other country where labor is applied to finish the production process. By contrast, Dixit and Grossman (1982) use a specific-factors model, with one of the commodities (manufacturing) produced in a continuum of stages using capital and labor (the other sector using land and labor).<sup>57</sup> These stages are arranged such that, as goods-in-process develop towards the final stage, more labor-intensive techniques are required. Thus with two countries, the labor-abundant country will tend to specialize in later stages of the productive spectrum.<sup>58</sup> They analyze how endowment changes alter the cut-off point, as well as investigating issues related to content protection.

### 3.1.4. Natural resources

As Chapter 8 in this volume discusses, the normative question of pricing natural resources (exhaustible or renewable) has received much attention in the literature of the past decade. The middle-products approach stresses that some activities, the extraction of natural resources, must take place locally although international trade then allows other countries access to these resources. Obviously, comparative advantage changes over time for countries engaged in exporting exhaustible resources. In an early work Vanek (1963) traced through the changing pattern of

<sup>57</sup>Both papers cite the use of the continuum concept in Dornbusch, Fischer, and Samuelson (1977).

<sup>58</sup>A limitation of both papers is the assumption that costs (or factor proportions) move monotonically from lower to higher stages of production. If not, trade may take place at many points in the productive spectrum in the absence of inhibiting transport costs.

United States trade in natural resources, and suggested that asymmetries in resource use and availability could account for the Leontief paradox.

In a context of multi-level trade, the costs of resource extraction in one country often depend on the availability of foreign capital. Kemp and Ohyama (1978) have presented a simple model of North–South trade in which South makes use of Northern capital to develop its resources and exports these resources to the North where they are used to produce final commodities.<sup>59</sup> They put their model to use in exploring the normative issue of different degrees of bargaining strength and ability to exploit via export taxes and tariffs in the two regions. But the model also stresses the involvement of capital flows in resource extraction. Schmitz and Helberger (1979) argue strongly for complementarity between trade in resources and trade in capital, a point also stressed by Williams in his 1929 article. We turn to consider more generally, now, the interaction between trade in goods and trade in factors.

### 3.2. *Trade in factors*

Bertil Ohlin lent his name to the model of trade most frequently used to illustrate the Classical paradigm whereby trade in final commodities is allowed but trade in factors is not. And yet his basic treatise (1933) contains extensive discussions of international factor movements – of both capital and labor – and their relationship to the international exchange of commodities. Meade (1955) also explored some of the issues involved when factors of production can participate in international markets. Most modern analytical treatments of the relationship between capital mobility and trade, however, start their bibliographical references with the work of Mundell (1957).

In the Mundell analysis both countries are assumed to share a common technology and to be incompletely specialized in producing two commodities with internally mobile labor and capital – the standard Heckscher–Ohlin framework. Even in the absence of international factor mobility free trade in these circumstances results in factor-price equalization. Mundell examines the implications of a small tariff levied by the country which imports the capital-intensive good. By the Stolper–Samuelson argument such a tariff raises the domestic real return to capital. If capital now becomes internationally mobile, it will be attracted to the tariff-levying country, and local production of the capital-intensive import-competing industry will rise. Thus the induced capital flow tends to reduce commodity trade; this process continues until all commodity trade is wiped out. In Mundell's model trade and factor mobility are substitutes in the sense that impediments to trade encourage factor mobility.

<sup>59</sup>This model is described in simplified terms by Findlay (1979).

Continuing research in this area initially followed Mundell in retaining the Heckscher–Ohlin production structure, although dispensing with the assumption that countries have identical technologies. Kemp (1966) and Jones (1967) investigated the relationship between tariffs and taxes on capital flows for a country simultaneously engaged in trade and investment of some of its capital stock abroad. A central characteristic of these analyses refers to the links which technology or markets provide between commodity prices and the rate of return to capital. A tariff that improves a country's commodity terms of trade may nonetheless worsen its real income if, say, such a price change depresses the rate of return to capital and the tariff-levying country is heavily engaged in foreign investment.<sup>60</sup>

Is commodity trade a substitute (perhaps imperfect) for factor mobility? In the Heckscher–Ohlin model used by Mundell, the answer is in the affirmative. Purvis (1972), however, argues that if technology differs between countries (as it does in the analysis of Kemp and Jones), the possibility for capital to move internationally may enlarge, rather than reduce, the volume of trade. That is, trade and factor movements may be complements.<sup>61</sup> The issue has been analyzed in a more general context by Markusen (1983). He argues that if the basis for trade is differences in factor endowments, as in Mundell, trade and factor movements will tend to be substitutes. However, if the basis for trade resides in other characteristics, international factor mobility is likely to enhance commodity trade – trade and factor movements tend to be complements.

Markusen surveys several possible bases for trade other than factor proportions – returns to scale, taxes, and imperfect competition as well as Ricardian-type differences in technology (as in Purvis). In each case a standard technique is employed: countries are assumed to be identical in every respect (including factor proportions) except for the single basis for trade. For example, suppose the home country has an absolute technical advantage in producing the labor-intensive good so that, when trade in goods (only) is allowed, the home country exports this commodity. Since both face the same commodity prices, the presumed technical superiority of the home country in the labor-intensive good must result in a higher wage rate and a lower return to capital at home than in the foreign country. If capital mobility is now allowed, capital must flow abroad and by the Rybczynski theorem this must raise the output in each country of that country's exportable; factor mobility has caused a complementary expansion in commodity trade.

<sup>60</sup> Chapter 5 discusses normative aspects of this model, as well as the phenomenon of a flat on the world transformation surface when both countries are diversified in production.

<sup>61</sup> In our discussion of natural resources we cited the suggestions of Schmitz and Helmberger (1970) that international capital flows encourage development and trade in natural resources; trade and capital flows are again complements.

Once some degree of international factor mobility is allowed, the broad question that is addressed by these models concerns the effect of increased factor mobility on the overall *level* of commodity trade. But there remains the somewhat related question raised at the outset in connection with trade in intermediates: does the international mobility of factors cause the *pattern* of trade to depart from what it would be in the absence of such factor movements? This issue has been discussed in the context of capital mobility in a Heckscher–Ohlin model by Jones (1970b),<sup>62</sup> and by Ferguson (1978).<sup>63</sup>

In these models of international capital mobility it is typically the case that ownership of the capital good is unchanged so that no actual sales of capital take place. The signal for a movement of capital is a discrepancy between rates of return among countries. Other models, especially in a growth context, have emphasized capital mobility in the form of sales of capital goods. Thus Oniki and Uzawa (1965), Baldwin (1966), and Inada (1968) allow for current production of capital goods, and, as well, for prices (costs of production) of capital goods and savings behavior to link trade in capital goods with relative commodity prices. In a properly specified model in which interest rates are equalized between countries it makes little difference whether capital goods are sold or ownership retained. But if interest rates in the country wishing to obtain the services of foreign capital are higher than in the source country, that country may not be willing to purchase capital goods at current prices even if the local stream of returns is somewhat higher.<sup>64</sup> Here we direct our attention away from growth models and the rate at which capital is accumulated in favor of more static models concerned with the endogenous response of the location of existing capital goods, the allocation being guided by current rates of return.<sup>65</sup>

Economists interested in industrial organization have wanted to explain the role of the multinational firm, with its expertise in particular well-defined spheres of activity, and this concern led to the important contribution by Caves (1971a).<sup>66</sup> To imbed his discussion in a general-equilibrium context, Caves set aside the Heckscher–Ohlin view of capital as homogeneous and inter-sectorally mobile in favor of the specific-factors model, in which endogenous capital flows have a direct effect on factor returns quite aside from any influence on commodity

<sup>62</sup>In particular, if capital is internationally mobile and technology differs between countries it is shown that the Harrod measure of this difference at a given rate of profit is a better indicator of trade patterns than the Hicksian measure, which is more applicable if factors are internationally immobile.

<sup>63</sup>In the context of the specific-factors model, Jones (1979b) notes that the situation in which the pattern of trade with capital mobility differs from that without mobility parallels the later stages of Vernon's (1966) product cycle. See also the remarks in Jones (1970b).

<sup>64</sup>This issue is discussed in more detail in Berglas and Jones (1977).

<sup>65</sup>Models of trade and growth are discussed in Chapters 4 and 6, and dynamic models of foreign investment in Chapters 4 and 5.

<sup>66</sup>A more extensive treatment of multinationals is provided in Caves (1982). See also the interesting work by Hymer (1976).

markets and prices, even if countries are incompletely specialized.<sup>67</sup> The specific-factors model with capital mobility leads to some results in accord with earlier Heckscher–Ohlin models.<sup>68</sup> But other important results are different.

To return to the question of possible complementarity between goods and factor flows, recall that in the Heckscher–Ohlin model trade flows that reflect differences in endowment patterns tend to be substitutes for the international mobility of capital. This is less clearly the case in the specific-factors model. Adopt once again the Markusen (1983) technique of having two countries identical except for a single basis for trade. Suppose the home country has a larger labor force and that this causes it to export the first commodity in a two-commodity setting.<sup>69</sup> Under free trade the wage rate at home will be lower and the returns to both types of specific capital will be higher than abroad. Whether subsequent international capital mobility reduces or expands commodity trade depends upon which type of capital is mobile. If type-1 capital is mobile, the flow into the home country serves to expand commodity trade, whereas if type-2 capital is mobile, home exports of commodity 1 will fall, instead. Indeed, in the latter case the pattern of commodity trade can be reversed following the flow of type-2 capital into the home country.<sup>70</sup> Of course if labor is internationally mobile instead, an outward flow of labor from the home country will restore relative endowment balance between countries and all trade will vanish.<sup>71</sup>

The phenomenon of “cross-hauling” of international capital may appear in the specific-factors model. Caves (1971a) gives an example in which an exogenous inflow of type-1 capital into a country serves to cause an outflow of type-2 capital via the consequent reduction in returns to *both* types of sector-specific capital. A more complete account of the possibility of two-way flows of international capital would examine the consequences on the endogenous location of both types of capital of an exogenous change in some key variable other than one or other stock of capital. The influence of commercial policy or resource discoveries in causing

<sup>67</sup>This change in models has given rise to an extensive literature. See Amano (1977), Berglas and Jones (1977), Jones (1979b), Burgess (1980), Batra and Ramachandran (1980), Khandker (1981), Jones, Neary, and Ruane (1981), and Jones and Dei (1983). The same approach underlies the staples model of Canadian economic history. See especially Chambers and Gordon (1966), Caves (1971b), and Easton and Reed (1981).

<sup>68</sup>For example, many of the patterns of optimal taxes and tariffs are similar. See Jones (1979b).

<sup>69</sup>This implies that  $\theta_{L1}\gamma_1 > \theta_{L2}\gamma_2$  so that the larger labor force raises output of commodity 1 at constant prices by relatively more than commodity 2. See Section 2.4 for details.

<sup>70</sup>This reversal of the trade pattern *must* occur if  $\theta_{L1}\gamma_1$  is sufficiently close to (but greater than)  $\theta_{L2}\gamma_2$  so that the initial trade flow is small relative to the difference between countries in labor supply and rates of return to capital.

<sup>71</sup>In this model trade in any factor will cause the difference between relative endowments in the two countries, as measured by  $\{\bar{L} - (\lambda_{L1}\bar{K}_1 + \lambda_{L2}\bar{K}_2)\}$ , to equal zero in a free-trade equilibrium, since only then will the return to the mobile factor be equated between countries. If the internationally mobile factor is the one which is initially in more ample supply in one country, factor movements will wipe out trade. But suppose, for example, that  $K_1$  is exogenously in greater supply at home and that  $K_2$  is endogenously mobile (internationally). Then  $K_2$  must flow out of the home country and thus enlarge the basis for trade (since the home country exports the first commodity).

one type of capital to flow out of a country while another flows in is suggested in two alternative models by Jones, Neary, and Ruane (1981).<sup>72</sup> For example, suppose that new resource discoveries lead to expansion in one sector of the economy, aided by an inflow of capital specific to this sector but internationally mobile. This is the setting for the “Dutch Disease,” whereby the return to capital in other sectors can be squeezed by the implied rise in wage rates. If this other capital is also mobile internationally, it may be able to avoid the consequences of such a squeeze by flowing to other countries not experiencing the resource boom.

International movements of labor have occasionally been pronounced. To the extent that the labor flow has primarily non-economic explanations, standard trade theory can analyze the consequences of such a movement on trade patterns, factor prices, etc.<sup>73</sup> Of more interest analytically are situations in which economic incentives provide the underlying rationale for labor mobility. The vast literature on the “brain drain” [e.g. Bhagwati and Hamada (1974)] attests to the important normative issues involved. We mention these only in passing, as well as the possible “buffer” use of international labor flows represented by the guest-worker system in Germany and other northern European countries (or the seasonal use of Mexican labor in the Southwestern region of the United States).<sup>74</sup> For some countries (Pakistan, Malawi, etc.) earnings of nationals abroad are so large that without such flows local wage rates and the volume of commodity trade would be much reduced.

Finally, note that in the Classical paradigm with no internationally mobile factors, trade is determined by positions of comparative advantage in which international differences between countries in political systems, degree of taxation, danger of expropriation, etc., have effects on the allocation of resources trapped within a nation’s boundaries only to the extent that they affect each sector differently. However, once factors of production are mobile internationally, such inter-country differences can assume major importance in determining where factors of production choose to be employed. The doctrine of comparative advantage then yields in some respects to the doctrine of “relative attractiveness”—the relative capacity of countries to attract internationally footloose productive factors.<sup>75</sup>

<sup>72</sup> Not all shocks lead to cross-hauling. For example, local growth in the labor supply is likely to cause an endogenous inflow of both kinds of capital.

<sup>73</sup> Ohlin (1933) describes cases in which the flow of labor has substituted for trade—e.g. French Huguenots in the seventeenth century moving to Germany and Holland and setting up textile production that weakened the French export position. In a recent paper Engerman (1982) documents the nineteenth century British pattern in sugar production whereby international movements of British capital and Indian labor provided the factors required to combine with the natural resources and climate of third regions (Mauritius, Trinidad, Natal, etc.).

<sup>74</sup> Ethier (1981) presents an interesting analysis of the temporary flows of unskilled labor, in part motivated by considerations of dumping which he analyzes in Ethier (1982a).

<sup>75</sup> For further details see Jones (1980).

### 3.3. *Trade in technology*

International exchange of technological knowledge clearly takes place, and yet economists find the phenomenon somewhat difficult to incorporate into formal models. Recent attempts include those of Smith (1974), Rodriguez (1975b), Berglas and Jones (1977), Findlay (1978a), and Krugman (1979a). These models differ in the form which the trade in technology is assumed to take as well as in the characterization of those aspects of economies most likely to encourage such technology transfer.

None of the papers cited attempts to explain either the level or the rate of improvement of technology in the advanced country. The focus, instead, is on the transfer of technology from the advanced region to the less developed areas. The paper by Smith (1974) considers the sale of vintage capital equipment by advanced to developing areas. Thus second-hand machines find a market in relatively low-wage countries although their economic usefulness in advanced areas has been exhausted. Berglas and Jones (1977) also consider a model in which technology is embodied in capital equipment which is located (not sold) by the advanced in the developing region. The attraction is the lower wage rate, and a deterrent is provided by higher perceived risks. Like the Findlay (1978a) model, both advanced and relatively backward capital coexist in the developing region, with rates of return not necessarily equalized.

One feature of a model in which the transfer of technology implies the transfer of the capital good is that less is thereby available in the source country. This is not the case with licensing arrangements whereby technology can be adopted in foreign countries without restricting its use at home. Rodriguez (1975b) considers such a case and concludes that the owner of the technology behaves like a monopolist in the foreign market. Optimal behavior is analyzed, much as in the earlier Kemp (1966) and Jones (1967) models of optimal tax and tariff patterns in a Heckscher–Ohlin world of capital mobility, except that the export of technology does not impair its availability at home. The Berglas and Jones model also considers optimal commercial policy for the advanced country and compares this with the alternative whereby the government follows a hands-off policy but a multinational firm controls the export of technology (via capital exports) with an eye towards its own return. Technology exports may easily prove excessive compared with the level that is optimal for the country in this case.

Findlay's (1978a) paper delves more deeply into the determinants of the rate at which technology is transferred. The two key ingredients involve the Veblen–Gerschenkron idea that the rate of improvement in technology in the backward country is larger the greater the gap separating its technology from that in the advanced area, and, secondly, the “contagion” postulate whereby the greater the direct contact with advanced productive technology (in the form of advanced capital located in the backward country) the more rapid is the improve-

ment in the less developed region. Findlay weaves these two postulates together to build a formal dynamic model of steady-state growth, foreign investment, and technology transfer.

A somewhat different explanation of the transfer of technology is given in Berglas and Jones (1977). Here the building-blocks are Arrow's (1962) concept of learning-by-doing (supplemented by the concept of "forgetting-by-not-doing") and the Atkinson and Stiglitz (1969) concept of the localization of technical progress.<sup>76</sup> The basic idea is that domestic factor prices determine not only the techniques a country uses, but also the regions in which its industries' isoquants tend to move in (with technical progress) or move out (where techniques not used are forgotten). Thus the effective isoquants of advanced (high-wage) countries do not dominate those of low-wage countries; instead, they lie closer to the capital axis and further from the (unskilled) labor axis. Such a view has a strong implication for trade in technology: countries relatively close to each other in stage of development (and so having similar factor price ratios) will experience a greater transfer of new technology than countries further apart. This view contrasts with the Veblen–Gerschenkron idea cited by Findlay. Furthermore, it provides an example (for technology trade) of a broader phenomenon: "similarity" between countries may enhance rather than discourage some kinds of trade. This is a theme to which we return in Section 4's discussion of monopolistic competition.<sup>77</sup>

Krugman's model postulates both a given rate of new goods (technology) introduced in the advanced region (the North) and a given lag before the less developed area (the South) can obtain the technology to produce these goods. With these two ingredients given exogenously, the Krugman model can in a simple fashion explore how North–South wage and real income relationships depend upon them both. The commodity composition of trade, of course, changes constantly; the North has a (monopoly-type) advantage in producing new goods, in a fashion described by Vernon's product cycle.

### 3.4. *Trade in securities*

The theory of international economics is often divided (as in these two volumes) into real and monetary sections. Most real trade theory, concerned as it is with question of composition (relative prices and outputs, internal and/or international distribution of income), finds it convenient to assume that a nation's aggregate spending matches its current income. This, of course, does not mean a

<sup>76</sup>See also the discussion in Jones (1970b).

<sup>77</sup>A recent paper by Feenstra and Judd (1982) discusses technology transfer in a framework of monopolistic competition. A fixed cost element is introduced by the assumption of an initial outlay on research and development that is centralized in one country.

barter economy. Instead, it implies either that asset accumulation does not take place or, if spending includes real investment, that capital goods are the only asset stocks that expand (as in some models of growth and trade). Precluded is a nation's use of its trading partners in an attempt to "live beyond its means" by issuing debt or to accumulate claims against foreigners' future production.

This assumption of balanced trade can be stoutly defended by pointing out that the qualitative answers to many compositional questions are not sensitive to the absence of trade deficits or surpluses. Nevertheless, for some questions the assumption needs to be removed. For example, Fischer and Frenkel (1974) provide a formal analysis of a small growing country engaged in commodity trade and able to trade securities with the rest of the world. With net trade in securities, various time paths of the balance of indebtedness are possible, and they correspond to less analytical discussions in development economics.

The recent surge of literature on the role of uncertainty in trade models, documented in detail in Chapter 9 below, suggests a somewhat different role for international trade in securities. Such trade may help countries share risks in much the same fashion as individuals do in the stock market.<sup>78</sup>

In Section 2 we discussed the "core propositions" associated with the Heckscher–Ohlin model. The earlier writings on uncertainty and trade often attacked these theorems as valid only in the absence of uncertainty. Helpman and Razin (1978) provide a way out of this situation by showing how a model may be specified that allows international trade in securities to validate once again these core propositions (with the exception of the Heckscher–Ohlin theorem itself). The trick is to identify real equities with the expected output in any industry of the inputs of labor and capital. Input decisions have to be made before uncertainty is resolved. In the first industry, for example,  $f_1(L_1, K_1)$  denotes the expected output of the first commodity. Uncertainty, however, leads the value of realized output to equal  $\theta_1(\alpha)f_1(L_1, K_1)$ , where  $\theta_1$  is a positive random variable whose value depends on the state of nature (denoted by  $\alpha$ ). Trade in commodities takes place after the uncertainty is resolved, and, if  $\theta_1$  does not equal unity, factor payments need not be matched by commodity prices and the standard link between the two is thereby ruptured. However, trade in securities allows security prices to take on the role filled by commodity prices in deterministic models, so that, for example, the equality of security prices between countries implies, under the standard assumptions, equality of factor prices as well. Of course, the significance of Helpman and Razin's approach is not just that it "rescues" the

<sup>78</sup>The basic paper cited by Helpman and Razin (1978) as providing a suitable framework in which to analyze international trade in securities is that of Diamond (1967). Of the vast literature of the 1970s attempting to deal with uncertainty and trade, the contributions by Pomery (1976, 1979) and Helpman and Razin (1978) go furthest in focusing on the possibility of trade in some form of stocks or securities as well as commodities. For earlier work, however, see Kemp and Liviatan (1973).

core propositions but that it draws attention to the importance of specifying which markets are assumed to extend across national boundaries.

#### 4. Multi-behavioral trade

Our use of the phrase “multi-behavioral” trade to capture the material discussed in this section needs explanation. Basically we are concerned with departures from purely competitive behavior, in some cases prompted by the existence of increasing returns to scale. But we also wish to discuss the consequences for positive trade theory of departures from the assumption that markets are “clean”—free of taxes or other distortions either at the goods or factor level. Just as in Section 3, this literature typically involves a *mixture* of elements—some clean competitive markets and some distorted or imperfectly competitive sectors.

##### 4.1. Market distortions

The patterns of trade predicted in standard trade models can be altered if distortions to commodity and factor markets exist. To the extent that trade theory has been concerned with the analysis of tariffs, the focus has been on the appearance domestically of productive activities that are ruled out in the harsher climate of free trade rather than on a reversal of trade patterns.<sup>79</sup> By contrast, subsidies can in general alter the direction of trade. In addition, as is well documented in the normative literature on the subject, the welfare consequences are potentially severe: for example, when comparative advantage is based upon artificially low payments to a factor in a nation’s export industry the misallocation of resources may (but need not) make free trade worse than autarky. [For an early analysis see Haberler (1950).]<sup>80</sup>

As well as having implications for trade patterns, the existence of certain types of factor-market distortions has called into question several of the core propositions of the Heckscher–Ohlin model. Magee (1969, 1971), Bhagwati and Srinivasan (1971), Herberg and Kemp (1971), and Jones (1971b) all deal with the Heckscher–Ohlin model in which a factor in one sector (say capital in  $X$ ) receives a fixed percentage premium over the return of the same factor in the other

<sup>79</sup>Deardorff (1980) describes as “natural” trade situations in which impediments such as tariffs do not artificially create new export industries.

<sup>80</sup>An even earlier example is the argument for protection on the basis of distortions in factor markets put forth by Manoilescu (1931). See also the critical reviews by Ohlin (1931) and Viner (1932), which anticipate many of the points made in the recent literature.

sector.<sup>81</sup> Potential paradoxes emerge: the output of  $X$  may fall as the relative price of  $X$  goes up or, alternatively, as the premium rises. Underlying these paradoxical results is the possibility that the factor-market distortion (whereby capital earns more in sector  $X$  than in sector  $Y$ ) may cause the ranking of industries by distributive shares (the value-intensity ranking) to differ from the ranking by physical factor proportions. (For example  $X$  may be physically labor intensive but nonetheless pay capital a higher share than  $Y$ ). The Stolper-Samuelson link between factor and commodity prices depends upon the value ranking, whereas the Rybczynski relationship asserts that at constant commodity prices an expansion in the labor force reduces output in the sector that is capital intensive in physical terms. Thus in the example above an increase in the relative price of  $X$  causes the wage rate to fall. At the intensive margin this leads both sectors to economize on capital. Outputs then adjust as they would at constant prices if the endowment of labor fell and capital rose, thus forcing a contraction of sector  $X$  since it is physically labor intensive.<sup>82</sup>

As shown by Neary (1978b), all the paradoxes which depend upon this divergence between factor-intensity rankings can be dismissed by invoking stability arguments. Under a class of adjustment processes which includes as a special case the "short-run capital-specificity" process discussed in Section 2.4, he investigates whether an economy will approach an equilibrium in which it is incompletely specialized and rates of return to capital are separated only by the amount of the distortion. The answer is that a small price-taking open economy does *not* approach such a long-run equilibrium if, at such a point, the physical and value intensity rankings diverge. Therefore, those paradoxes, such as an inverse relationship between price and output, which depend upon a divergence between the alternative factor-intensity rankings are associated with unstable equilibria and so will never be observed.<sup>83</sup>

A factor-market distortion that takes the form of a proportional premium earned by a factor in one sector is not the only kind which has received attention in the literature.<sup>84</sup> For example, Lefeber (1971), Brecher (1974) and Schweinberger (1978) have focused on the existence of economy-wide minimum wages. The use of the Heckscher-Ohlin model for this purpose presents difficul-

<sup>81</sup>Thus these models build upon the earlier analysis of the corporation income tax in Harberger (1962). See also the analysis of union wages in Johnson and Mieszkowski (1970).

<sup>82</sup>In terms of the notation introduced in Section 2.3, the reversal of physical and value rankings implies that the product  $|\lambda| |\theta|$  is negative.

<sup>83</sup>Some debate has emerged on Neary's conclusions. See Herberg and Kemp (1980), and Neary's reply (1980a).

<sup>84</sup>Indeed, it may not be the appropriate way to represent certain distortions. For example, Jones (1971b), argues that the analysis of wage differentials caused by union activity, as in the analysis of

ties in that a small open economy facing world-determined terms of trade has at most one wage rate consistent with incomplete specialization. Should this rate fall short of the minimum wage, the country is driven to complete specialization and some labor may become unemployed.<sup>85</sup> A recent generalization of this kind of distortion is provided by Neary (1980b), who stresses the relationship between Heckscher–Ohlin models with minimum wages à la Brecher and the Mundell case discussed in Section 3.2 in which the rigid factor price reflects international factor mobility.

Minimum wage rates may not apply throughout the economy. One of the most interesting recent developments in trade and development theory concerned with factor-market distortions is the model developed by Harris and Todaro (1970). They distinguish between a rural (agricultural) sector and an urban sector. Only in the latter does a minimum wage prevail, at a higher level than exists in the rural sector. For labor-market equilibrium to obtain, the urban wage, scaled down by a fraction representing the ratio of urban employment to the total urban labor force (including unemployed job-seekers), must equal the rural wage. Krueger (1977) has an interesting discussion of the implications of such a model for positions of comparative advantage. Corden and Findlay (1975) alter the assumption, made by Harris and Todaro, that capital is sector-specific, and show that in a Heckscher–Ohlin setting an increase in the urban minimum wage may cause industrial output to expand. Further properties of the Harris–Todaro model with intersectoral capital mobility are developed in Khan (1980) and Neary (1981).

One persistent difficulty with this entire literature is the ad hoc character of the distortions.<sup>86</sup> An important departure from this view is the notion that economic resources are devoted to obtaining licenses or special treatment leading to enhanced rents or revenues. The locus classicus for this argument in a trade context is Krueger (1974), and related work has been carried out by Bhagwati and Srinivasan (1980) and Findlay and Wellisz (1982) in Heckscher–Ohlin and specific-factors models respectively. The phenomenon of rent-seeking raises important normative questions which we do not discuss here.

Johnson and Mieskowski (1970), might better be captured by a specific-factors model in which union labor earns a premium that depends *endogenously* on its control of union membership. By restricting entry the union would raise union wages but might raise non-union wages by a greater relative amount and thus lower its percentage premium. This kind of objection does not arise in Harberger's (1962) case of corporate income taxation where the discrepancy between returns to capital is caused by exogenous government behavior.

<sup>85</sup>A specific-factors model with (temporarily) sticky wages is analyzed in Norman and Jones (1979). In their model a (given) wage may coexist with unemployment, but the economy is nonetheless incompletely specialized.

<sup>86</sup>An exception is the work of Carruth and Oswald (1982), who examine in general equilibrium the effects of introducing a utility-maximizing trade union which simultaneously chooses the wage and employment level of its members.

#### 4.2. Increasing returns

The assumption that technology exhibits constant returns to scale is almost universally adopted in general-equilibrium models, including those small-scale versions popular in the theory of international trade. The case of decreasing returns poses little analytical difficulty, but economists have typically been wary of modelling increasing returns. Part of the problem derives from a desire to preserve the assumption of perfectly competitive behavior. (Some forms of imperfect competition rest intimately on the existence of scale economies, and we discuss them in Section 4.3.) But a strand of the literature attempts to maintain the competitive framework by assuming that increasing returns are external to the firm and internal to the industry.

The effects of these increasing returns on the core propositions of the Heckscher–Ohlin model serve as the focus for the Jones (1968) discussion of variable returns to scale. The slope of the transformation schedule differs from the commodity price ratio to the extent that the degree of increasing returns differs between industries. The transformation schedule may not be bowed out everywhere, depending on the strength of returns to scale and the difference in factor intensities.<sup>87</sup> The effect of an increase in the labor endowment on outputs at constant commodity prices, the Rybczynski relationship, depends on the local shape of the transformation schedule, as does the Stolper–Samuelson theorem. The possibility that production functions are non-homothetic introduces an additional distinction between average and marginal factor intensities,<sup>88</sup> and this may affect the Stolper–Samuelson result as well.

The wide array of possible outcomes with increasing returns was questioned by Mayer (1974a) for the same reason that Neary (1978b) invoked later in connection with the literature on factor market distortions: a plausible set of stability conditions is inconsistent with incompletely specialized equilibria in which relative prices and outputs are inversely related. Such restrictions serve to reestablish the Rybczynski result and (if marginal and average factor intensity rankings coincide) the Stolper–Samuelson theorem as well.

A somewhat different approach to increasing returns is reflected in the early paper by Melvin (1969) and, more recently, by Markusen and Melvin (1981). They treat increasing returns as providing a basis for trade alternative to differences in factor endowments or productivity and examine the consequences for the gains from trade. Whereas the Melvin (1969) paper considered trade

<sup>87</sup>The question of the shape of the transformation schedule with increasing returns, especially near the axes, is discussed thoroughly in Herberg and Kemp (1969).

<sup>88</sup>Recent work by Panagariya (1980) simplifies the issue by assuming homotheticity in production but relaxing some other assumptions made in the Jones (1968) analysis, e.g. that the expansion of any industry at constant commodity (or factor) prices increases the demand for both productive factors.

between two identical countries in which both goods exhibit increasing returns, Markusen and Melvin introduce asymmetry in two key ways: only one commodity is produced under increasing returns, and although countries share identical factor proportions and tastes, they differ in absolute size. Economies of scale thus establish a comparative advantage for the large country in the production of the commodity which exhibits increasing returns to scale.<sup>89</sup>

In these papers scale economies are linked exclusively to national levels of output. A recent article by Ethier (1979) has zeroed in on the distinction between these “economies of scale in the traditional sense”<sup>90</sup> and increasing returns that are tied to the scale of world demand and output. As world output of a particular commodity increases, greater degrees of specialization are allowed, and this can give rise to increasing returns even if national output is unaltered. Each country produces two commodities (wheat,  $W$  and manufacturing,  $M$ ) and a bowed-out production-possibilities curve connects output of wheat (the constant-returns sector) and the *scale* of manufacturing activity,  $m$ . But actual *output* of manufactures,  $M$ , equals some multiple,  $k$ , of  $m$ , where  $k$  captures the extent of increasing returns as linked to the scale of world output,  $(m + m^*)$ . [Thus  $k$  equals  $(m + m^*)^{\alpha-1}$ , where  $\alpha$  exceeds unity.] The relationship between  $m$  and  $W$  thus follows the standard Heckscher–Ohlin model, whereas that between outputs  $M$  and  $W$  also incorporates the extent of world increasing returns.<sup>91</sup> Ethier finds traditional offer curve analysis too cumbersome because of the dependence of each nation’s output on the other nation’s output and so introduces a new concept (the allocation curve) which incorporates this interdependence. With the aid of allocation curves, Ethier analyzes the stability of world equilibrium using the Marshallian conditions appropriate to the case of decreasing costs.

Perhaps Ethier’s most interesting proposition concerns the effect in this model of having the underlying bowed-out curves between wheat and the scale of manufacturing production become more similar between countries. The volume of trade in manufactured goods (intra-industry trade) rises absolutely and relative to inter-industry trade. This is a theme he develops in more detail in Ethier (1982b), where he combines world increasing returns with more traditional national increasing returns.<sup>92</sup> Although Ethier’s approach is different, his interest in the

<sup>89</sup>Both these articles also discuss the possible complementarity of goods trade and factor flows when increasing returns provide the basis for trade, along lines we discussed above in Section 3.2 in describing the recent paper by Markusen (1983).

<sup>90</sup>This is the phrase used by Balassa (1967) and cited in Ethier (1979).

<sup>91</sup>In discussing Graham’s argument for protection, Ethier (1982c) switches away from an underlying Heckscher–Ohlin model to a Ricardian model with increasing returns of the national variety, since the production possibility schedule must then be bowed in. In a Heckscher–Ohlin model increasing returns promote a bowed-in schedule, but differences in factor intensities support increasing opportunity costs.

<sup>92</sup>The core propositions of Heckscher–Ohlin theory are also analyzed in Ethier (1982b), and versions of these survive the introduction of increasing returns relatively intact.

contrast between inter-industry and intra-industry trade is shared by the recent burgeoning literature on monopolistic competition.

#### *4.3. Imperfect competition*

Free entry can rule out profits even if returns to scale are increasing. Similarly, the lack of free entry may encourage monopolistic or monopsonistic behavior even if returns to scale are constant. Alternatively, increasing returns may support monopolistic behavior or, if entry is free, markets characterized by monopolistic competition.

Like economies of scale, elements of monopoly behavior are typically absent from models attempting to use general-equilibrium techniques. [An exception for small-scale models is the 1973 article by Melvin and Warne.] In the presence of monopoly, production remains on the transformation schedule, but the price ratio is distorted away from its slope. To the extent that free trade dispels the firm's monopoly power, a country may gain from trade both for the usual reasons and because of the enforced change in market structure. As discussed by Caves (1974), if the import sector is monopolized, trade may serve to raise production of importables. If the export sector is monopolized, trade may lower the relative price of exportables. Both of these movements run counter to those found in traditional competitive markets.

The analysis of monopoly is extended by Markusen (1981) to a two-country setting with monopolies in the same sector in each country, each treating its rival's output as fixed. In a fashion made familiar in earlier articles by Melvin and by Markusen, the two countries are lined up before trade so that they have similar tastes, factor endowments, and constant-returns technology, but one country is larger than the other. This difference in size leads to trade in which the large country imports the product of the monopolized sector. The combination of monopoly and increasing returns leads to ambiguity in the trade pattern, since we have already seen in Section 4.2 that increasing returns alone has the opposite bias, encouraging the large country to *export* the good which is produced under economies of scale.<sup>93</sup>

These models highlight the potential effect of the increased competition in product markets resulting when free trade lessens a firm's monopoly power. However, even if monopoly power is completely eliminated, a large firm can still act as a monopsonist in domestic factor markets. This issue has been treated by

<sup>93</sup>The analysis in Markusen (1981) can be viewed as an attempt to deal with oligopoly in trade models. A less formal discussion is provided by Caves (1979). In more recent work Markusen (1982) has attempted to analyze one potential reason for the behavior and existence of multinational firms—the gains available to multi-plant operations when some activities, such as research and development, can be centralized in one location but made available to all plants.

Itoh (1978), Feenstra (1980), McCulloch and Yellen (1980), and Markusen and Robson (1980). Feenstra links his analysis to the literature on factor-market distortions discussed in Section 4.1; monopsonies provide a rationale for such distortions. The locus of a nation's outputs lies below the competitive transformation schedule (but above the hyperplane joining the end points) and, in addition, the slope of such a distorted locus may not equal the price ratio. Monopsony has the effect of making factor intensities systematically less dissimilar between the monopsonized sector and the competitive sector. All the authors cited share these results, while Markusen and Robson also illustrate how a monopsonist may raise output above the levels expected in a competitive sector. Itoh considers, as well, the joint existence of monopsony and foreign investment, thus moving away from the Classical paradigm in two different respects. A multinational firm may loom large in a small country's labor market and thus may distort wage rates to its advantage.

The introduction of scale economies to support Chamberlinian monopolistic competition in a general-equilibrium setting represents one of the most active recent areas of interest in trade theory. Although Negishi (1972) discussed the problem in general terms, it is the recent work of Krugman (1979b, 1980, 1981), Dixit and Norman (1980), Lancaster (1980) and Helpman (1981a) that has attracted most attention. The empirical phenomenon that inspires all these papers is the importance of intra-industry trade, a feature emphasized by Balassa (1967), Grubel (1970), and Grubel and Lloyd (1975), among others.

Krugman's models are particularly simple. He adopts the Dixit and Stiglitz (1977) model of monopolistic competition whereby a consumer's utility is positively related to the number of varieties of manufactured products and each variety is produced subject to the increasing returns to scale that result when an element of fixed costs is added to labor costs that are proportional to output. The 1979 article assumes that each economy produces many varieties of a single type of (manufactured) good, whereas elements of inter-sectoral trade are introduced in the 1981 article by letting each economy produce two kinds of products, with many varieties of each kind. The background production structure is an ingeniously simple blend of the exchange and Ricardian models: each type of product uses only one kind of labor, which is available to all varieties of that type but immobile between types. The trade pattern that emerges depends both on the difference between relative endowments of each kind of labor in the two countries and upon relative sizes of countries.

The model developed by Helpman (1981a) differs both in the specification of demand [consumers have preferred characteristics of products à la Lancaster (1979)] and in terms of the production structure. Each economy produces not only varieties of the manufactured good that are subject to increasing returns but also a commodity (food) exhibiting standard constant returns to scale. Moreover, both sectors use capital and labor which are perfectly mobile domestically.

Helpman's model allows both for traditional Heckscher–Ohlin-type trade involving two broad product categories (inter-industry trade) as a result of differences in factor endowments and for the exchange of different varieties of manufactured goods (intra-industry trade).

Two general types of questions are raised in this literature. First, is trade stimulated by differences between countries or by similarities? In the models satisfying the Classical paradigm it is differences between countries in factor endowments, technology, or tastes that encourage relatively large volumes of trade. The recent models that incorporate monopolistic competition suggest that intra-industry trade is likely to be more extensive between economies similar in size and factor proportions, although inter-industry trade is still encouraged by differences in underlying factor endowments.<sup>94</sup> Thus some kinds of trade are stimulated by similarities between countries.<sup>95</sup>

The second type of question, which we had occasion to raise in our earlier discussion of comparative advantage, concerns the power of autarkic prices to predict trade patterns. Because manufactures, say, are produced subject to increasing returns, they tend to be relatively cheap in large countries before trade. But suppose countries are identical in every respect except size; when trade is opened up there is no inter-sectoral (food for manufactures) trade. The reason pre-trade commodity prices cease to have trade-predictive powers is that certain key characteristics determining autarkic prices are utterly changed once trade becomes possible. In autarky, a large country tends to have low relative prices for goods subject to increasing returns since it is the extent of the *local* market that determines cost. Once trade takes place, prices in both large and small countries depend on the extent of the same *world* market. The problem is analogous to that discussed in Section 3; a country may export a final commodity that is relatively expensive in autarky if it requires as an input an intermediate good which becomes cheap only with trade.

Finally, both Krugman and Helpman discuss the role of factor prices in these models. Krugman (1981) emphasizes that if countries are roughly similar in their proportions of the two types of labor, not only will intra-industry trade tend to dominate, but trade could allow all factor returns to rise. By contrast, in

<sup>94</sup>Ethier (1982b) reaches similar conclusions with a different model (described in Section 4.2). A blend of the Ethier and Helpman (1981a) approaches is developed by Helpman (1981b), in which differentiated middle products instead of final consumption goods are subject to increasing returns. Falvey's recent model (1981), discussed in Section 2.5, illustrates how intra-industry trade can be explained without relying on increasing returns and monopolistic competition. In an analogous vein, Brander (1981) models intra-industry trade without requiring differentiated production.

<sup>95</sup>Linder (1961) presents an argument in which tastes are important in explaining trade. Unlike Classical models, however, it is similarity in taste patterns, as linked to per capita income levels, that encourages trade; countries produce commodities that are consumed not only locally but by other countries with roughly similar per capita levels of income. Recall, as well, our discussion of technology transfer in Section 3.3; such transfer is more likely to take place among countries at comparable stages of development.

traditional models trade tends to depress the return to the country's scarce factor. In discussing how pre-trade commodity prices may fail to predict trade patterns, Helpman points out that relative factor prices are a better predictor of inter-industry trade. And, with free trade between countries sharing the same technology, factor prices can once again be equalized even in the presence of increasing returns and monopolistic competition.

## 5. Concluding remarks

We have tried to indicate in this chapter recent developments in the positive theory of international trade, especially since it was last surveyed in the mid-1960s. As an organizing device we have treated the Classical paradigm as a set of assumptions under which trade is limited to final commodities and markets are undistorted and characterized by constant returns to scale and perfect competition. There is no doubt that the bulk of the older literature in trade theory abides by these assumptions, just as it is clear that much of the progress made in the field since it was last surveyed has involved departures from the Classical paradigm. This new work has in part been motivated by certain key features of real-world trade: the vast exchange of raw materials and commodities that require further processing before being consumed, the large volume of intra-industry trade, and the importance of the size of markets.

These extensions in analysis have generally been made without throwing away building blocks found in the earlier literature. For example, Helpman (1981a) discusses the importance of monopolistic competition by blending a Chamberlinian sector with a sector exhibiting Heckscher–Ohlin properties. Krugman (1982) adopts a continuum version of Ricardo to model trade with a Heckscher–Ohlin flavor: high-technology countries tend to have a comparative advantage in "technology-intensive" commodities. Furthermore, extensions of the simple models of production within the Classical paradigm have broken out of the traditional two-by-two mold to analyze the importance of joint production, complementarity between factors, and general properties in higher dimensions. Earlier work on simpler trade models has proved of value in all these extensions.

## References

- Amano, A. (1977), "Specific factors, comparative advantage and international investment", *Economica*, 44:131–144.  
Arrow, K.J. (1962), "The economic implications of learning by doing", *Review of Economic Studies*, 29:155–173.  
Atkinson, A.B. and J.E. Stiglitz (1969), "A new view of technological change", *Economic Journal*, 79:573–578.  
Balassa, B. (1967), *Trade liberalization among industrial countries* (McGraw-Hill, New York).

- Baldwin, R.E. (1966), "The role of capital-goods trade in the theory of international trade", *American Economic Review*, 56:841–848.
- Batra, R. and F. Casas (1976), "A synthesis of the Heckscher–Ohlin and the neoclassical models of international trade", *Journal of International Economics*, 6:21–38.
- Batra, R. and R. Ramachandran (1980), "Multinational firms and the theory of international trade and investment", *American Economic Review*, 70:278–290.
- Berglas, E. and R.W. Jones (1977), "The export of technology", in: K. Brunner and A. Meltzer, eds., *Optimal policies, control theory and technology exports*, Carnegie-Rochester Conference on Public Policy, 7:159–202.
- Bhagwati, J.N. (1958), "Immiserizing growth: A geometrical note", *Review of Economic Studies*, 25:201–205.
- Bhagwati, J.N. (1964), "The pure theory of international trade: A survey", *Economic Journal*, 74:1–84.
- Bhagwati, J.N. (1972), "The Heckscher–Ohlin theorem in the multi-commodity case", *Journal of Political Economy*, 80:1052–1055.
- Bhagwati, J.N. and K. Hamada (1974), "The brain drain, international integration of markets for professionals and unemployment: A theoretical analysis", *Journal of Development Economics*, 1:19–42.
- Bhagwati, J.N., R.W. Jones, R.A. Mundell and J. Vanek, eds. (1971), *Trade, balance of payments, and growth: Essays in honor of Charles P. Kindleberger* (North-Holland, Amsterdam).
- Bhagwati, J.N. and T.N. Srinivasan (1971), "The theory of wage differentials: Production response and factor price equalization", *Journal of International Economics*, 1:19–35.
- Bhagwati, J.N. and T.N. Srinivasan (1973), "The general equilibrium theory of effective protection and resource allocation", *Journal of International Economics*, 3:259–281.
- Bhagwati, J.N. and T.N. Srinivasan (1980), "Revenue seeking: A generalization of the theory of tariffs", *Journal of Political Economy*, 88:1069–1087.
- Brander, J.A. (1981), "Intra-industry trade in identical commodities", *Journal of International Economics*, 11:1–14.
- Brecher, R. (1974), "Minimum wage rates and the pure theory of international trade", *Quarterly Journal of Economics*, 88:98–116.
- Brecher, R. and J. Bhagwati (1981), "Foreign ownership and the theory of trade and welfare", *Journal of Political Economy*, 89:497–511.
- Burgess, D.F. (1976), "Tariffs and income distribution: Some empirical evidence for the United States", *Journal of Political Economy*, 84:17–45.
- Burgess, D.F. (1978), "On the distributional effects of direct foreign investment", *International Economic Review*, 19:647–664.
- Burgess, D.F. (1980), "Protection, real wages, and the neoclassical ambiguity with interindustry flows", *Journal of Political Economy*, 88:783–802.
- Carruth, A.A. and A.J. Oswald (1982), "The determination of union and non-union wage rates", *European Economic Review*, 16:285–302.
- Caves, R.E. (1960), *Trade and economic structure* (Harvard University Press, Cambridge, MA).
- Caves, R.E. (1971a), "International corporations: The industrial economics of foreign investment", *Economica*, 38:1–27.
- Caves, R.E. (1971b), "Export-led growth and the new economic history", in: J.N. Bhagwati et al., eds. (1971) 403–442.
- Caves, R.E. (1974), "International trade, international investment, and imperfect markets", *Special Papers in International Economics*, No. 10, International Finance Section, Princeton University.
- Caves, R.E. (1979), "International cartels and monopolies in international trade", in: R. Dornbusch and J. Frenkel, eds., *International economic policy* (Johns Hopkins University Press, Baltimore).
- Caves, R.E. (1982), *Multinational enterprise and economic analysis* (Cambridge University Press, Cambridge).
- Caves, R.E. and R.W. Jones (1981), *World trade and payments*, 3rd edn. (Little Brown, Boston).
- Chambers, E.J. and D.F. Gordon (1966), "Primary products and economic growth: An empirical measurement", *Journal of Political Economy*, 74:315–332.
- Chang, W. (1979), "Some theorems of trade and general equilibrium with many goods and factors", *Econometrica*, 47:709–726.

- Chang, W., W. Ethier and M. Kemp (1980), "The theorems of international trade with joint production", *Journal of International Economics*, 10:377–394.
- Chichilnisky, G. (1980), "Basic goods, the effects of commodity transfers and the international economic order", *Journal of Development Economics*, 7:505–519.
- Chipman, J.S. (1965–66), "A survey of the theory of international trade", *Econometrica*, 33:477–519, 33:685–760, 34:18–76.
- Chipman, J.S. (1969), "Factor price equalization and the Stolper–Samuelson theorem", *International Economic Review*, 10:399–406.
- Chipman, J.S. (1972), "The theory of exploitative trade and investment policies: A reformulation and synthesis", in: L.E. DiMarco, ed., *International economics and development: Essays in honor of Raul Prebisch* (Academic Press, New York) 881–916.
- Chipman, J.S. (1974), "The transfer problem once again", in: G. Horwitz and P.A. Samuelson, eds., *Trade, stability, and macroeconomics: Essays in honor of Lloyd A. Metzler* (Academic Press, New York) 19–78.
- Corden, W.M. (1966), "The structure of a tariff system and the effective protective rate", *Journal of Political Economy*, 74:221–237.
- Corden, W.M. (1971), "The substitution problem in the theory of effective protection", *Journal of International Economics*, 1:37–57.
- Corden, W.M. and R. Findlay (1975), "Urban unemployment, intersectoral capital mobility and development policy", *Economica*, 42:59–78.
- Corden, W.M. and J.P. Neary (1982), "Booming sector and de-industrialization in a small open economy", *Economic Journal*, 92:825–848.
- Deardorff, A.V. (1974), "Factor proportions and comparative advantage in the long run: Comment", *Journal of Political Economy*, 82:829–833.
- Deardorff, A.V. (1979), "Weak links in the chain of comparative advantage", *Journal of International Economics*, 9:197–209.
- Deardorff, A.V. (1980), "The general validity of the law of comparative advantage", *Journal of Political Economy*, 88:941–957.
- Deardorff, A.V. and J.A. Hanson (1978), "Accumulation and a long-run Heckscher–Ohlin theorem", *Economic Inquiry*, 16:288–292.
- Diamond, P.A. (1967), "The role of a stock market in a general equilibrium model with technological uncertainty", *American Economic Review*, 57:759–776.
- Diewert, E. (1974), "Applications of duality theory", in: M. Intriligator and D. Kendrick, eds., *Frontiers of quantitative economics*, Vol. II (North-Holland, Amsterdam).
- Diewert, E. and A.D. Woodland (1977), "Frank Knight's theorem in linear programming revisited", *Econometrica*, 45:375–398.
- Dixit, A.K. (1980), "A model of trade in natural resources and capital", mimeo.
- Dixit, A.K. and G.M. Grossman (1982), "Trade and protection with multi-stage production", *Review of Economic Studies*, 49:583–594.
- Dixit, A.K. and V.D. Norman (1979), "Notes on the Ricardo–Viner model", mimeo.
- Dixit, A.K. and V.D. Norman, (1980), *Theory of international trade* (Cambridge University Press, Cambridge).
- Dixit, A.K. and J.E. Stiglitz (1977), "Monopolistic competition and optimum product diversity", *American Economic Review*, 67:297–308.
- Dornbusch, R. (1974), "Real and monetary aspects of the effects of exchange rate changes", in: R. Aliber, ed., *National monetary policies and the international financial system* (University of Chicago Press, Chicago), 64–81.
- Dornbusch, R. (1975), "Exchange rates and fiscal policy in a popular model of international trade", *American Economic Review*, 65:859–871.
- Dornbusch, R., S. Fischer and P.A. Samuelson (1977), "Comparative advantage, trade, and payments in a Ricardian model with a continuum of goods", *American Economic Review*, 67:823–839.
- Dornbusch, R., S. Fischer and P.A. Samuelson (1980), "Heckscher–Ohlin trade theory with a continuum of goods", *Quarterly Journal of Economics*, 94:203–224.
- Drabicki, J.Z. and A. Takayama (1979), "An antinomy in the theory of comparative advantage", *Journal of International Economics*, 9:211–223.
- Easton, S.T. and C. Reed (1981), "The staple model", unpublished.

- Engerman, S.L. (1984), "From servants to slaves to servants: Contract labor and European expansion", in: E. van den Boogaart and P.C. Emmer, eds., *Colonialism and migration: Indentured labour before and after slavery* (Martinus Nijhoff, Leiden University Press).
- Ethier, W. (1971), "General equilibrium theory and the concept of the effective rate of protection", in: Grubel and Johnson, eds., *Effective tariff protection* (GATT and GIIS, Geneva) 17–44.
- Ethier, W. (1972a), "Input substitution and the concept of the effective rate of protection", *Journal of Political Economy*, 80:34–47.
- Ethier, W. (1972b), "Nontraded goods and the Heckscher–Ohlin model", *International Economic Review*, 13:132–147.
- Ethier, W. (1974), "Some of the theorems of international trade with many goods and factors", *Journal of International Economics*, 4:199–206.
- Ethier, W. (1977), "The theory of effective protection in general equilibrium: Effective-rate analogues of nominal rates", *Canadian Journal of Economics*, 10:233–245.
- Ethier, W. (1979), "Internationally decreasing costs and world trade", *Journal of International Economics*, 9:1–24.
- Ethier, W. (1981), "International trade and labor migration", unpublished.
- Ethier, W. (1982a), "Dumping", *Journal of Political Economy*, 90:487–506.
- Ethier, W. (1982b), "National and international returns to scale in the modern theory of international trade", *American Economic Review*, 72:389–405.
- Ethier, W. (1982c), "Decreasing costs in international trade and Frank Graham's argument for protection", *Econometrica*, 50: 1243–1268.
- Falvey, R.E. (1981), "Commercial policy and intra-industry trade", *Journal of International Economics*, II:495–511.
- Feenstra, R.C. (1980), "Monopsony distortions in an open economy: A theoretical analysis", *Journal of International Economics*, 10:213–235.
- Feenstra, R.C. and K. Judd (1982), "Tariffs, technology transfer, and welfare", *Journal of Political Economy*, 90:1142–1165.
- Ferguson, D.G. (1978), "International capital mobility and comparative advantage", *Journal of International Economics*, 8:373–396.
- Findlay, R. (1970), "Factor proportions and comparative advantage in the long run", *Journal of Political Economy*, 78:27–34.
- Findlay, R. (1978a), "Relative backwardness, direct foreign investment, and the transfer of technology: A simple dynamic model", *Quarterly Journal of Economics*, 92:1–16.
- Findlay, R. (1978b), "An 'Austrian' model of international trade and interest rate equalization", *Journal of Political Economy*, 86:989–1007.
- Findlay, R. (1979), "Economic development and the theory of international trade", *American Economic Review, Papers and Proceedings*, 69:186–190.
- Findlay, R. (1980), "The terms of trade and equilibrium growth in the world economy", *American Economic Review*, 70:291–299.
- Findlay, R. and H. Grubert (1959), "Factor intensities, technological progress, and the terms of trade", *Oxford Economic Papers*, 11:111–121.
- Findlay, R. and S. Wellisz (1982), "Rent-seeking, welfare and the political economy of trade restrictions", in: J. Bhagwati, ed., *Import competition and response* (University of Chicago Press, Chicago).
- Fischer, S. and J. Frenkel (1974), "Economic growth and stages of the balance of payments", in: G. Horwich and P.A. Samuelson, eds., *Trade, stability and macroeconomics: Essays in honor of Lloyd A. Metzler* (Academic Press, New York) 503–521.
- Gale, D. (1974), "Exchange equilibrium and coalitions", *Journal of Mathematical Economics*, 1:63–66.
- Graham, F.D. (1923), "The theory of international values re-examined", *Quarterly Journal of Economics*, 38:54–86.
- Grossman, G.M. (1981), "Partially mobile capital: A general approach to two-sector trade theory", mimeo.
- Grossman, G.M. and C. Shapiro (1982), "A theory of factor mobility", *Journal of Political Economy*, 90: 1054–1069.
- Grubel, H.G. (1970), "The theory of intra-industry trade", in: I.A. McDougall and R.H. Snape, eds.,

- Studies in international economics: Monash conference papers (North-Holland, Amsterdam) 35–51.
- Grubel, H.G. and P.J. Lloyd (1975), *Intra-industry trade: The theory and measurement of international trade in differentiated products* (Macmillan, London).
- Gruen, F.H. and W.M. Corden (1970), "A tariff that worsens the terms of trade", in: I.A. McDougall and R.H. Snape, eds., *Studies in international economics: Monash conference papers* (North-Holland, Amsterdam) 55–58.
- Haberler, G. (1950), "Some problems in the pure theory of international trade", *Economic Journal*, 60:223–240.
- Harberger, A.C. (1962), "The incidence of the corporation income tax", *Journal of Political Economy*, 70:215–240.
- Harris, J.R. and M.P. Todaro (1970), "Migration, unemployment and development: A two-sector analysis", *American Economic Review*, 60:126–142.
- Harrod, R.F. (1958), "Factor price relations under free trade", *Economic Journal*, 68:245–255.
- Heckscher, E. (1919), "The effect of foreign trade on the distribution of income", *Ekonomisk Tidskrift*, 497–512; reprinted as Chapter 13 in: A.E.A. Readings in the theory of international trade (Blakiston, Philadelphia, 1949) 272–300.
- Helpman, E. (1976), "Solutions of general equilibrium problems for a trading world", *Econometrica*, 44:547–559.
- Helpman, E. (1977), "Nontraded goods and macroeconomic policy under a fixed exchange rate", *Quarterly Journal of Economics*, 91:469–480.
- Helpman, E. (1981a), "International trade in the presence of product differentiation, economies of scale and monopolistic competition: A Chamberlin–Heckscher–Ohlin approach", *Journal of International Economics*, 11:305–340.
- Helpman, E. (1981b), "International trade in differentiated middle products", presented to International Economic Association conference on structural adjustment in trade-dependent advanced economies, Yxtaholm, Sweden, August 1982.
- Helpman, E. and A. Razin (1978), *A theory of international trade under uncertainty* (Academic Press, New York).
- Herberg, H. and M.C. Kemp (1969), "Some implications of variable returns to scale", *Canadian Journal of Economics*, 2:403–415.
- Herberg, H. and M.C. Kemp (1971), "Factor market distortions, the shape of the locus of competitive outputs and the relation between product prices and equilibrium outputs", in: J. Bhagwati et al., eds. (1971) 22–48.
- Herberg, H. and M.C. Kemp (1980), "In defense of some 'paradoxes' of trade theory", *American Economic Review*, 70:812–814.
- Hicks, J.R. (1939), *Value and capital* (Oxford University Press, London).
- Hicks, J.R. (1953), "An inaugural lecture: 2. The long-run dollar problem", *Oxford Economic Papers*, 5:121–135.
- Hymer, S.H. (1976), *The international operations of national firms: A study of direct foreign investment* (M.I.T. Press, Cambridge).
- Inada, K. (1968), "Free trade, capital accumulation and factor price equalization", *Economic Record*, 44:322–341.
- Inada, K. (1971), "The production coefficient matrix and the Stolper–Samuelson condition", *Econometrica*, 39:219–240.
- Itoh, M. (1978), "A theory of imperfect competition in international trade and investment", Ph.D. dissertation, University of Rochester.
- Johnson, H.G. (1953), "Equilibrium growth in an international economy", *The Canadian Journal of Economics and Political Science*, 19:478–500.
- Johnson, H.G. (1955), "Economic expansion and international trade", *The Manchester School of Economic and Social Studies*, 23:95–112.
- Johnson, H.G. (1956), "The transfer problem and exchange stability", *Journal of Political Economy*, 64:212–225.
- Johnson, H.G. (1957), "Factor endowments, international trade, and factor prices", *Manchester School of Economic and Social Studies*, 25:270–283.
- Johnson, H.G. (1960), "A note on income distribution", Appendix to "Income distribution, the offer curve and the effects of tariffs", *Manchester School of Economic and Social Studies*, 28:215–242.

- Johnson, H.G. and P.M. Mieszkowski (1970), "The effects of unionization on the distribution of income: A general equilibrium approach", *Quarterly Journal of Economics*, 84:539–561.
- Jones, R.W. (1956), "Factor proportions and the Heckscher-Ohlin theorem", *Review of Economic Studies*, 24:1–10.
- Jones, R.W. (1961a), "Stability conditions in international trade: A general equilibrium analysis", *International Economic Review*, 2:199–209.
- Jones, R.W. (1961b), "Comparative advantage and the theory of tariffs: A multi-country, multi-commodity model", *Review of Economic Studies*, 28:161–175.
- Jones, R.W. (1965), "The structure of simple general equilibrium models", *Journal of Political Economy*, 73:557–572.
- Jones, R.W. (1967), "International capital movements and the theory of tariffs and trade", *Quarterly Journal of Economics*, 81:1–38.
- Jones, R.W. (1968), "Variable returns to scale in general equilibrium theory", *International Economic Review*, 9:261–272.
- Jones, R.W. (1969), "Tariffs and trade in general equilibrium: Comment", *American Economic Review*, 59:418–424.
- Jones, R.W. (1970a), "The transfer problem revisited", *Economica*, 37:178–184.
- Jones, R.W. (1970b), "The role of technology in the theory of international trade", in: R. Vernon, ed., *The technology factor in international trade* (NBER, New York) 73–92.
- Jones, R.W. (1971a), "Effective protection and substitution", *Journal of International Economics*, 1:59–81.
- Jones, R.W. (1971b), "Distortions in factor markets and the general equilibrium model of production", *Journal of Political Economy*, 79:437–459.
- Jones, R.W. (1971c), "A three-factor model in theory, trade, and history", in: J.N. Bhagwati et al., eds. (1971) 3–21.
- Jones, R.W. (1974a), "The Metzler tariff paradox: Extensions to nontraded and intermediate commodities", in: G. Horwitz and P.A. Samuelson, eds., *Trade, stability, and macroeconomics: Essays in honor of Lloyd A. Metzler* (Academic Press, New York) 3–18.
- Jones, R.W. (1974b), "Trade with non-traded goods: The anatomy of interconnected markets", *Economica*, 41:121–138.
- Jones, R.W. (1974c), "The small country in a many-commodity world", *Australian Economic Papers*, 13:225–236.
- Jones, R.W. (1975a), "Presumption and the transfer problem", *Journal of International Economics*, 5:263–274.
- Jones, R.W. (1975b), "Income distribution and effective protection in a multicommodity trade model", *Journal of Economic Theory*, 11:1–15.
- Jones, R.W. (1977), "Two-ness in trade theory: Costs and benefits", *Special papers in International Economics*, Princeton University, No. 12.
- Jones, R.W. (1979a), "Technical progress and real incomes in a Ricardian trade model", Chapter 17 in: R. Jones, *International trade: Essays in theory* (North-Holland, Amsterdam) 279–286.
- Jones, R.W. (1979b), "Trade and direct investment: A comment", in: R. Dornbusch and J. Frenkel, eds., *International economic policy* (Johns Hopkins University Press, Baltimore) 105–111.
- Jones, R.W. (1980), "Comparative and absolute advantage", *Schweizerische zeitschrift fur volkswirtschaft und statistik*, No. 3, 235–260; also available as Reprint Series No. 153, Institute for International Economic Studies, University of Stockholm.
- Jones, R.W. and W.M. Corden (1976), "Devaluation, non-flexible prices, and the trade balance for a small country", *Canadian Journal of Economics*, 9:150–161.
- Jones, R.W. and F. Dei (1983), "International trade and foreign investment: A simple model", *Economic Inquiry*, forthcoming.
- Jones, R.W. and S.T. Easton (1983), "Factor intensities and factor substitution in general equilibrium", *Journal of International Economics*, forthcoming.
- Jones, R.W. and J.P. Neary (1979), "Temporal convergence and factor intensities", *Economics Letters*, 3:311–314.
- Jones, R.W., J.P. Neary and F. Ruane (1981), "Two-way capital flows: Cross-hauling in models of foreign investment", unpublished.
- Jones, R.W. and D.S. Purvis (1983), "International differences in response to common external

- shocks: The role of purchasing power parity”, Chapter 2 in: E. Classen and P. Salin, eds., Recent issues in the theory of flexible exchange rates (North-Holland, Amsterdam).
- Jones, R.W. and J. Scheinkman (1977), “The relevance of the two-sector production model in trade theory”, *Journal of Political Economy*, 85:909–935.
- Kemp, M.C. (1966), “The gain from international trade and investment: A neo-Heckscher–Ohlin approach”, *American Economic Review*, 56:788–809.
- Kemp, M.C. and W. Ethier (1976), “A note on joint production and the theory of international trade”, Chapter 7 in: M.C. Kemp, Three topics in the theory of international trade (North-Holland, Amsterdam) 81–84.
- Kemp, M.C. and K. Inada, (1969), “International capital movements and the theory of international trade”, *Quarterly Journal of Economics*, 83:524–528.
- Kemp, M.C. and R.W. Jones (1962), “Variable labor supply and theory of international trade”, *Journal of Political Economy*, 70:30–36.
- Kemp, M.C. and N. Liviatan (1973), “Production and trade patterns under uncertainty”, *Economic Record*, 49:215–227.
- Kemp, M.C. and M. Ohyama (1978), “On the sharing of trade gains by resource-poor and resource-rich countries”, *Journal of International Economics*, 8:93–115.
- Kemp, M.C. and L. Wegge (1969), “On the relation between commodity prices and factor rewards”, *International Economic Review*, 10:407–413.
- Khan, M.A. (1980), “The Harris–Todaro hypothesis and the Heckscher–Ohlin–Samuelson trade model: A synthesis”, *Journal of International Economics*, 10:527–548.
- Khandker, A.W. (1981), “Multinational firms and the theory of international trade and investment: A correction and a stronger conclusion”, *American Economic Review*, 71:515–516.
- Khang, C. (1973), “Factor substitution in the theory of effective protection: A general equilibrium analysis”, *Journal of International Economics*, 3:227–243.
- Komiya, R. (1967), “Non-traded goods and the pure theory of international trade”, *International Economic Review*, 8:132–152.
- Komiya, R. and T. Shizuki (1967), “Transfer payments and income distribution”, *Manchester School of Economic and Social Studies*, 35:245–255.
- Kotlikoff, L.J., E.E. Leamer, and J. Sachs (1981), “The international economics of transitional growth: The case of the United States”, Working Paper No. 773, National Bureau of Economic Research, Cambridge, MA.
- Krueger, A.O. (1974), “The political economy of the rent-seeking society”, *American Economic Review*, 64:291–303.
- Krueger, A.O. (1977), Growth, distortions, and patterns of trade among many countries, Princeton Studies in International Finance, No. 40.
- Krugman, P.R. (1979a), “A model of innovation, technology transfer, and the world distribution of income”, *Journal of Political Economy*, 87:253–266.
- Krugman, P.R. (1979b), “Increasing returns, monopolistic competition and international trade”, *Journal of International Economics*, 9:469–479.
- Krugman, P.R. (1980), “Scale economies, product differentiation and the pattern of trade”, *American Economic Review*, 70:950–959.
- Krugman, P.R. (1981), “Intraindustry specialization and the gains from trade”, *Journal of Political Economy*, 89:959–973.
- Krugman, P.R. (1982), “A ‘technology gap’ model of international trade”, presented to International Economic Association conference on structural adjustment in trade-dependent advanced economies, Yxtaholm, Sweden, August 1982.
- Lancaster, K. (1979), Variety, equity, and efficiency (Columbia University Press, New York).
- Lancaster, K. (1980), “Intra-industry trade under perfect monopolistic competition”, *Journal of International Economics*, 10:151–175.
- Lefebvre, L. (1971), “Trade and minimum wage rates”, in: J.N. Bhagwati et al., eds. (1971) 91–114.
- Leontief, W.W. (1953), “Domestic production and foreign trade: The American capital position re-examined”, *Proceedings of the American Philosophical Society*, 97:332–349.
- Lerner, A.P. (1936), “The symmetry between import and export taxes”, *Economica*, 3:306–313.
- Lerner, A.P. (1952), “Factor prices and international trade”, *Economica*, 19:1–15.
- Linder, S.B. (1961), An essay on trade and transformation (John Wiley and Sons, New York).

- McCulloch, R. and J. Yellen (1980), "Factor market monopsony and the allocation of resources", *Journal of International Economics*, 10:237–247.
- McDougall, I. (1965), "Non-traded goods and the transfer problem", *Review of Economic Studies*, 32:67–84.
- McKenzie, L.W. (1954), "Specialization and efficiency in world production", *Review of Economic Studies*, 21:165–180.
- McKenzie, L.W. (1955), "Equality of factor prices in world trade", *Econometrica*, 23:239–257.
- Magee, S.P. (1969), "Factor market distortions and the pure theory of international trade", Massachusetts Institute of Technology Ph.D. dissertation, Cambridge, MA.
- Magee, S.P. (1971), "Factor market distortions, production, distribution and the pure theory of international trade", *Quarterly Journal of Economics*, 85:623–643.
- Manoilescu, M. (1931), *The theory of protection and international trade* (P.S. King and Son, London).
- Markusen, J.R. (1981), "Trade and the gains from trade with imperfect competition", *Journal of International Economics*, 11:531–551.
- Markusen, J.R. (1983a) "Factor movements and commodity trade as complements", *Journal of Integrational Economics*, 43: 341–356.
- Markusen, J.R. (1983b) "Multinationals, multi-plant economies and the gains from trade", *Journal of International Economics*, forthcoming.
- Markusen, J.R. and J.R. Melvin (1981), "Trade, factor prices, and the gains from trade with increasing returns to scale", *Canadian Journal of Economics*, 14: 450–469.
- Markusen, J.R. and A. Robson (1980), "Simple general equilibrium and trade with a monopsonized sector", *Canadian Journal of Economics*, 13:668–682.
- Martin, J.P. and J.P. Neary (1980), "Variable labour supply and the pure theory of international trade: An empirical note", *Journal of International Economics*, 10:549–560.
- Mayer, W. (1974a), "Variable returns to scale in general equilibrium theory: A comment", *International Economic Review*, 15:225–235.
- Mayer, W. (1974b), "Short-run and long-run equilibrium for a small open economy", *Journal of Political Economy*, 82:955–967.
- Meade, J. (1955), *Trade and welfare* (Oxford University Press, London).
- Melvin, J.R. (1968), "Production and trade with two factors and three goods", *American Economic Review*, 58:1248–1268.
- Melvin, J.R. (1969), "Increasing returns to scale as a determinant of trade", *Canadian Journal of Economics*, 3:389–402.
- Melvin, J.R. and R.D. Warne (1973), "Monopoly and the theory of international trade", *Journal of International Economics*, 3:117–134.
- Metzler, L. (1949), "Tariffs, the term of trade, and the distribution of national income", *Journal of Political Economy*, 57:1–29.
- Mill, J.S. (1848), *Principles of political economy* (Parker & Co., London).
- Mundell, R.A. (1957), "International trade and factor mobility", *American Economic Review*, 47:321–335.
- Mundell, R.A. (1960), "The pure theory of international trade", *American Economic Review*, 50:67–110.
- Mussa, M. (1974), "Tariffs and the distribution of income: The importance of factor specificity, substitutability, and intensity in the short and long run", *Journal of Political Economy*, 82:1191–1204.
- Mussa, M. (1978), "Dynamic adjustment in the Heckscher–Ohlin model", *Journal of Political Economy*, 86:775–794.
- Mussa, M. (1979), "The two-sector model in terms of its dual: A geometric exposition", *Journal of International Economics*, 9:513–526.
- Mussa, M. (1982), "Imperfect factor mobility and the distribution of income", *Journal of International Economics*, 12:125–142.
- Neary, J.P. (1978a), "Short-run capital specificity and the pure theory of international trade", *Economic Journal*, 88:488–510.
- Neary, J.P. (1978b), "Dynamic stability and the theory of factor-market distortions", *American Economic Review*, 68:671–682.
- Neary, J.P. (1978c), "Capital subsidies and employment in an open economy", *Oxford Economic Papers*, 30:334–356.

- Neary, J.P. (1979), "Two-by-two international trade theory with many goods and factors", mimeo.
- Neary, J.P. (1980a), "This side of paradox, or, in defense of the correspondence principle: A reply to Herberg and Kemp", *American Economic Review*, 70:815–818.
- Neary, J.P. (1980b), "International factor mobility, minimum wage rates and factor price equalization: A synthesis", Seminar Paper No. 158, Institute for International Economic Studies, University of Stockholm.
- Neary, J.P. (1980c), "Devaluation and the dynamics of the trade balance in a small open economy", mimeo.
- Neary, J.P. (1981), "On the Harris-Todaro model with intersectoral capital mobility", *Economica*, 48:219–234.
- Neary, J.P. and D.D. Purvis, (1982), "Sectoral shocks in a dependent economy: Long-run adjustment and short-run accomodation", *Scandinavian Journal of Economics*, 84:229–253.
- Negishi, T. (1972), General equilibrium theory and international trade (North-Holland, Amsterdam).
- Noman, K. and R.W. Jones (1979), "A model of trade and unemployment", in: J. Green and J. Scheinkman, eds., *General equilibrium, growth, and trade: Essays in honor of Lionel McKenzie* (Academic Press, New York) 297–322.
- Ohlin, B. (1931), "Protection and non-competing groups", *Weltwirtschaftliches Archiv*, 33:30–45.
- Ohlin, B. (1933), *Interregional and international trade* (Harvard University Press, Cambridge).
- Oniki, H. and H. Uzawa (1965), "Patterns of trade and investment in a dynamic model of international trade", *Review of Economic Studies*, 32:15–38.
- Panagariya, A. (1980), "Variable returns to scale in general equilibrium theory once again", *Journal of International Economics*, 10:499–526.
- Pearce, I.F. (1952), "A note on Mr. Lerner's paper", *Economica*, 19:16–18.
- Pearce, I.F. (1961), "The problem of the balance of payments", *International Economic Review*, 2:1–28.
- Pearce, I.F. (1970), *International trade* (Norton, New York).
- Pomery, J.G. (1976), "International trade and uncertainty: Simple general equilibrium models involving randomness", Ph.D. Dissertation, University of Rochester.
- Pomery, J.G. (1979), "Uncertainty and international trade", Chapter 4 in: R. Dornbusch and J. Frenkel, eds., *International economic policy: Theory and evidence* (Johns Hopkins, Baltimore) 112–157.
- Purvis, D.D. (1972), "Technology, trade and factor mobility", *Economic Journal*, 82:991–999.
- Ramaswami, V.K. and T.N. Srinivasan (1971), "Tariff structure and resource allocation in the presence of substitution", in: J.N. Bhagwati et al., eds. (1971) 291–299.
- Rodriguez, C. (1975a), "International factor mobility, nontraded goods, and the international equalization of prices of goods and factors", *Econometrica*, 43:115–124.
- Rodriguez, C. (1975b), "Trade in technological knowledge and the national advantage", *Journal of Political Economy*, 83:121–135.
- Ruffin, R.J. (1981), "Trade and factor movements with three factors and two goods", *Economic Letters*, 7:177–182.
- Ruffin, R.J. and R.W. Jones (1977), "Protection and real wages: The neoclassical ambiguity", *Journal of Economic Theory*, 14:337–348.
- Rybczynski, T. M. (1955), "Factor endowments and relative commodity prices", *Economica*, 22:336–341.
- Salter, W.E.G. (1959), "Internal and external balance: The role of price and expenditure effects", *Economic Record*, 35:226–238.
- Samuelson, P.A. (1948), "International trade and the equalisation of factor prices", *Economic Journal*, 58:163–184.
- Samuelson, P.A. (1949), "International factor-price equalization once again", *Economic Journal*, 59:181–197.
- Samuelson, P.A. (1952), "The transfer problem and transport costs: The terms of trade when impediments are absent", *Economic Journal*, 62:278–304.
- Samuelson, P.A. (1953), "Prices of factors and goods in general equilibrium", *Review of Economic Studies*, 21:1–20.
- Samuelson, P.A. (1954), "The transfer problem and transport costs, II: Analysis of effects of trade impediments", *Economic Journal*, 64:264–289.
- Samuelson, P.A. (1962), "Parable and realism in capital theory: The surrogate production function",

- Review of Economic Studies, 29:193–206.
- Samuelson, P.A. (1965), “Equalization by trade of the interest rate along with the real wage”, in: R.E. Baldwin et al., eds., *Trade, growth, and the balance of payments: Essays in honor of Gottfried Haberler* (Rand McNally, Chicago) 35–52.
- Samuelson, P.A. (1969), “The way of an economist”, in: P.A. Samuelson, ed., *International economic relations, Proceedings of the Third Congress of the International Economic Association* (Macmillan, London) 1–11.
- Samuelson, P.A. (1971a), “On the trail of conventional beliefs about the transfer problem”, in: J.N. Bhagwati et al., eds. (1971) 327–351.
- Samuelson, P.A. (1971b), “An exact Hume–Ricardo–Marshall model of international trade”, *Journal of International Economics*, 1:1–18.
- Samuelson, P.A. (1971c), “Ohlin was right”, *Swedish Journal of Economics*, 73:365–384.
- Samuelson, P.A. (1982), “Two country Ricardian analysis for discrete goods and for a continuum of goods”, *Journal of International Economics*, forthcoming.
- Sanyal, K.K. (1980), “Stages of production: The role of international trade”, Ph.D. dissertation, University of Rochester.
- Sanyal, K.K. and R.W. Jones (1982), “The theory of trade in middle products”, *American Economic Review*, 72:16–31.
- Schmitz, A.P. and P. Helmberger (1970), “Factor mobility and international trade: The case of complementarity”, *American Economic Review*, 60:761–767.
- Schweinberger, A.G. (1975), “Intermediate products and comparative advantage”, *Economic Record*, 51:671–682.
- Schweinberger, A.G. (1978), “Employment subsidies and the theory of minimum wage rates in general equilibrium”, *Quarterly Journal of Economics*, 92:361–374.
- Schweinberger, A.G. (1980), “Medium run resource allocation and short run capital specificity”, *Economic Journal*, 90:330–340.
- Smith, M.A.M. (1974), “International trade in second-hand machines”, *Journal of Development Economics*, 1:261–278.
- Sodersten, B. and K. Vind (1968), “Tariffs and trade in general equilibrium”, *American Economic Review*, 58:394–408.
- Stolper, W. and P.A. Samuelson (1941), “Protection and real wages”, *Review of Economic Studies*, 9:58–73.
- Suzuki, K. (1983), “A synthesis of the Heckscher–Ohlin and the neoclassical models of international trade: A comment”, *Journal of International Economics*, 14:141–144.
- Travis, W.P. (1964), *The theory of trade and protection* (Harvard University Press, Cambridge).
- Uzawa, H. (1961), “On a two-sector model of economic growth”, *Review of Economic Studies*, 29:40–47.
- Vanek, J. (1963), *The natural resource content of United States foreign trade, 1870–1955* (M.I.T. Press, Cambridge).
- Vernon, R. (1966), “International investment and international trade in the product cycle”, *Quarterly Journal of Economics*, 80:190–207.
- Viner, J. (1932), Review of: *The theory of protection and international trade*, by M. Manoilescu, *Journal of Political Economy*, 40:121–125.
- Walsh, V. (1956), “Leisure and international trade”, *Economica*, 23:253–260.
- Whitin, T.M. (1953), “Classical theory, Graham’s theory, and linear programming in international trade”, *Quarterly Journal of Economics*, 67:520–544.
- Williams, J.H. (1929), “The theory of international trade reconsidered”, *Economic Journal*, 39:195–209.
- Wilson, C. (1980), “On the general structure of Ricardian models with a continuum of goods: Applications to growth, tariff theory, and technical change”, *Econometrica*, 48:1675–1702.
- Woodland, A. (1977a), “A dual approach to equilibrium in the production sector in international trade theory”, *Canadian Journal of Economics*, 10:50–68.
- Woodland, A. (1977b), “Joint outputs, intermediate inputs and international trade theory”, *International Economic Review*, 18:517–533.
- Yano, M. (1981), “Welfare aspects in the transfer problem”, *Journal of International Economics*, forthcoming.