

# **Eli Heckscher and the Holy Trinity**

Ronald W. Jones

University of Rochester

Fifty years have passed since the death of Eli Heckscher. As well, this year marks the fiftieth anniversary of the appearance of Wassily Leontief's famous article proclaiming what has become known as the Leontief Paradox concerning the trade pattern in the United States. Received doctrine from the Swedish pair of Eli Heckscher and Bertil Ohlin had prepared us to expect that American exports would be capital-intensive in their production techniques compared with its import-competing sector. Not so, argued Leontief, and this bomb-shell spurred a raft of theoretical dissertations among young students on both sides of the Atlantic as well as a plethora of empirical work that continues to this day. Fortunately for English speakers, a few years before Heckscher's death Prof. Svend Laursen and his wife prepared a translation from the Swedish of Heckscher's 1919 article for the 1949 *Readings in the Theory of International Trade* (edited by Howard Ellis and Lloyd Metzler). This article received a revised translation in the gem of a book, *Heckscher-Ohlin Trade Theory*, (1991, MIT Press) prepared and edited by Harry Flam and M. June Flanders. Although the primary objective of this latter work was to provide a translation, for the first time, of Bertil Ohlin's 1924 dissertation, *The Theory of Trade* (Handelns Teori), it also served to confirm the importance of Heckscher's pioneering article, written five years previously. It is perhaps ironic that, as

this conference confirms, almost the entire academic career of Eli Heckscher was concerned with issues of economic history, whereas this single article on international trade theory was sufficient to award him the lead position in a “hyphen trophy” of the label, “Heckscher-Ohlin Trade Theory”.

In the prefatory remarks to the 1949 translation of his article, Heckscher, in referring to the work of his former student, Ohlin, remarks:

“My previous treatment....does not, in the eyes of its author, contain much of value over and above Ohlin’s books....” (p. 43, of Flam and Flanders, 1991).

An innocent reader of such a remark might conclude that Ohlin’s work appeared first, and that Heckscher was admitting that he did not have much more of substance to add. Such modesty is seen clearly to have been misplaced on re-reading the Heckscher article, as well as the Foreword (by Paul Samuelson) and the Introduction (by Flam and Flanders) in the 1991 book. Some years ago Wilfred Ethier (1974) arranged the main substantive contributions of Heckscher-Ohlin Theory into four sub-categories. Two of these, *viz.* the Heckscher-Ohlin Theorem about the nature of trade, arguing that with technologies assumed the same everywhere trade patterns reflected differences in relative factor endowments, and the Factor-Price Equalization Theorem, positing that free trade in commodities could bring about an absolute equalization of wage rates and other factor returns even without any international mobility of the factors of production, were spelled out rather clearly in Heckscher’s original treatment. Furthermore, his discussion of the effect of tariff protection on the distribution of income foreshadows the later classical account provided by Stolper and Samuelson (1941), while his remarks on the

international mobility of factors stimulated by a protective tariff can be said to anticipate some of Mundell (1957).

Whereas Ohlin would later prove reluctant to accept that trade could bring about full factor-price equalization, Heckscher was perhaps too eager to push this possibility since in talking about quality variations in factors he states that “the number of factors of production is thus practically unlimited” (p. 48). The problem with this is the “numbers game”; if the number of factors exceeds the number of produced commodities, commodity prices by themselves do not determine factor returns. Factor endowments have a role to play so that trade in commodities cannot be expected to equalize the returns to factors among the trading countries. More on this below.

Putting quality differences aside, both Heckscher and Ohlin make frequent reference to what I refer to as a classical *holy trinity* of factors, namely *land, capital, and labor*: As Samuelson remarks about Ohlin in his Forward to the Flam and Flanders volume:

“Already in 1924 Ohlin has melded Heckscher and Walras. But neither then, nor in 1933 and 1967, did Ohlin descend from full generality to strong and manageable cases – such as two factors of production and two-or-more goods. What a pity. Not only did Ohlin leave to my generation these easy pickings, but in addition he would for the first time have really understood his own system had he played with graphable versions.” (Flam and Flanders, p. ix).

The same is not quite true of Heckscher, in that he briefly discusses (p. 56) a 2x2 example in which wheat and textiles are produced by labor and land. But his example is rather constrained. He assumes that with trade the price of textiles is cut in half relative to the price of wheat, and that this causes the wage rate also to be cut in half. No basis

for this relationship is given. It implies that textiles only use labor (and wheat only land) and in this sense is a quite special 2x2 example.<sup>1</sup>

In the rest of these remarks I concentrate on what can be said about Heckscher-Ohlin trade theory if the classical trinity of land, capital and labor is maintained. In short, if Heckscher had taken the route of laying out the propositions that would be valid in this three-factor case, what remarks would be justified? And how did he connect the three-factor case to the factor-price equalization possibility?

### **The Holy Trinity with One Commodity in Each Country**

Most simple models of trade in the Heckscher-Ohlin tradition assume that each country can produce a (same) pair of commodities. But this is not necessary. In a two-commodity world trade could take place with each country specialized to a different commodity. In such a case, whether there are two factors of production or three makes little difference to the conclusion that free trade will generally *not* result in factor price equalization. And an explanation of the trade pattern is trivial – each country exporting the sole commodity produced there, regardless of any comparison of autarky factor prices. So what extra is added by having a third factor?

The existence of a third factor of production introduces the possibility that two of these factors have a complementarity relationship with each other, whereby an increase in one factor's return would, at given output, cause the other factor to be used less intensively. (Of course the third factor must be used more intensively in order to

---

<sup>1</sup> The assumption that wheat uses only land and no labor is necessary for Heckscher's remark that the wage rate is cut in half *relative to the rental on land*. If wheat uses labor as well as land in this 2x2 example, and the price of wheat is constant, the rental on land would be driven up, and thus the wage rate would be cut by more than half relative to land's rental.

maintain output since less must be utilized of the factor that has gone up in price.) Even without complementarity, a factor may have a different degree of substitutability with each of the other two. As seen below, this can matter for the issue of the effect of trade on the distribution of income, an issue of primary concern to Heckscher.

## **The Specific Factors Model**

The Specific-Factors Model, with an early treatment by Gottfried Haberler (1936) and formally developed by Jones (1971) and Samuelson (1971), is perhaps the most simple way of sticking with the Holy Trinity of land, labor and capital but avoiding the complications that enter when any productive activity uses all three factors. That is, simplicity of the type familiar from 2x2 Heckscher-Ohlin models is maintained by positing that each sector uses a productive factor not used in the other while both make use of a factor that is freely mobile between sectors. Many of the subsequent uses of the model consider the pair of specific factors to be of the same general type (e.g. capital), so that over time one kind of specific factor can be transformed into the other. This interpretation suggests the specific-factors model is a short-run version of the 2x2 Heckscher-Ohlin model (e.g. as proposed by J. Peter Neary, 1978). Alternatively, this model might consider the three factors as distinct, as in the Holy Trinity. Thus suppose labor is completely mobile between sectors, capital is used only to produce manufactures, and land is used only in the production of agricultural goods.

With this interpretation the model can yield strong results on the two issues of primary concern to Heckscher, *viz.* the effect of countries having different factor endowments on the pattern of trade and the consequences of such trade on the distribution of income.

Certainly a country that is relatively land abundant is apt to be an exporter of agricultural products, and one that is relatively capital abundant will tend to export manufactures.

As an aside, it is useful to recall that in the development of trade theory two distinct meanings of relative factor endowments have been highlighted. On the one hand is the comparison of relative physical volumes in endowments. On the other is a comparison of how relative factor returns would compare before international trade takes place.

Heckscher's interpretation of relative factor endowments clearly belongs to this latter category, and developments in Heckscher-Ohlin theory have not only pointed out that the two interpretations are different, but that the price definition of relative factor intensity is the stronger of the two: Asymmetric demand conditions in two countries could account for a physically relatively capital abundant country finding capital relatively dear in autarky if tastes there are biased heavily towards the capital-intensive good. In such a case the pattern of trade predicted by the Heckscher-Ohlin Theorem would be violated if a comparison of physical proportions was the criterion of relative factor abundance, but nonetheless would be upheld with the price version that was used by Heckscher (Jones, 1956).

Although dissimilarities either in land rents or returns to capital in autarky would have strong effects on relative commodity prices (and hence trade patterns), what is the significance of one country having relatively cheap labor before trade? As the theory points out, such a difference in the (price version of) endowment patterns has less of an effect on commodity prices because labor is used in both industries. However, by itself a lower wage rate in one country would tend to make relatively inexpensive the commodity

in which labor's distributive factor share is higher. Factor endowments all count in influencing the trade pattern, just as they do in the simple 2x2 Heckscher-Ohlin model.

As suggested earlier, factor-price equalization with trade is not to be expected in this setting since the number of factors (3) exceeds the number of produced commodities (2). What can be said that is similar to results of the Stolper-Samuelson type for the 2x2 model is that returns to the specific factors are *magnified* reflections of any change in relative commodity prices. An increase in the relative price of manufactures, say, unambiguously improves the real return to capital and reduces that to land. The fate of laborers is subject to what has been called "the neoclassical ambiguity", the nominal wage rising in terms of agriculture and falling in terms of manufactures. The magnification effects for the specific factors are reflections of the asymmetry in production technology whereby in each sector it takes both factors to produce, separately, each commodity (the assumption of no joint production).

### **The General 3x2 Model**

Letting all three factors in the Holy Trinity be involved in both commodities produced is a natural extension of the specific factors model, and was examined in detail by Raveendra Batra and Francisco Casas (1976), Katsuhiko Suzuki (1983), and Jones and Stephen Easton (1983). Just as in the earlier case of a single commodity produced, different degrees of substitutability among factors and the possibility of complementarity can no longer be avoided. Changes in the terms of trade affect the returns to each of the three factors, but the possibilities are wider than in the specific factors model. The difference in the ranking of factor intensities by industry is, of course, less extreme than

in the specific factors model. Suppose, nonetheless, that in such a ranking land is the most intensively used input in agriculture, capital in manufacturing, and once again labor is the “middle” factor. The effect of commodity price changes on income distribution could be similar to that in the easier-to-analyze specific factors case. But it need not be since asymmetry in substitutability among factors counts. As an extreme example, suppose that land and capital are better substitutes for each other than is either with labor. This means that it would be fairly difficult for a commodity price change to alter the ratio of land’s return to that of capital by very much. But if the relative price of manufactures, say, goes up, in a competitive market place in which commodity prices are matched by unit costs, the relative cost of manufactures must rise. If labor’s distributive share in manufactures is larger than it is in agriculture, one way of having relative costs in manufactures go up to match the price increase is to have a large relative increase in the nominal wage rate, with land’s return rising very little, or perhaps falling, so as not to vary much from the return to capital.

### **Heckscher’s Example of Factor-Price Equalization**

If two economies share the same technological knowledge, with each input possessing the same skills from country to country, but with different relative endowments, trade in two commodities would generally *not* serve to equalize factor returns because the number of commodities is smaller than the number of factors. Heckscher (pp. 54-55 in Flam and Flanders) discusses an example in which he seems to disagree. His discussion of this example is, in my view, rather opaque, but he seems to be saying that with common fixed coefficients in the two countries, with two commodities (meat is commodity 1, machinery

is commodity 2), and with one unit of each factor required per unit of commodity 1 as the fixed input-output coefficients and, for the second commodity, one unit of land, 3 units of capital and 4 units of labor required as inputs per unit output<sup>2</sup>, he concludes: “Exchange will thus continue until equalization is complete.”

There are two pitfalls I see in this example. First, with rigid input/output coefficients and only two commodities produced, there is only a restricted set of possible factor supplies that could result in full employment and thus positive factor returns. The restrictions that are required can be revealed, first, by considering the full-employment conditions for capital and labor:

$$X_1 + 3X_2 = K$$

$$X_1 + 4X_2 = L$$

where the  $X_i$  denote the two outputs and fixed factor endowments of capital and labor are denoted by  $K$  and  $L$ . The solutions obtained are that  $X_1$  equals  $(4K-3L)$  and that  $X_2$  equals  $(L-K)$ . In order that these market-clearing relationships can be obtained with positive outputs of the two commodities,  $K$  must exceed  $\frac{3}{4} L$  but fall short of  $L$ . In addition, the market for land ( $T$ ) clears if  $X_1 + X_2 = T$ , requiring that

$$K = (1/3) T + (2/3) L,$$

and this, with the previous restriction, implies that  $T$  lies between  $\frac{1}{4} L$  and  $L$ . Figure 1 illustrates for given arbitrary labor endowment the only possible (linear) combinations of capital and land that allow full employment and positive outputs for the prescribed rigid technological coefficients. Note that it is not a unique endowment bundle; the two

---

<sup>2</sup> Curiously enough the input coefficients of capital and labor in machinery (industry 2) cited by Flam and Flanders are 4 and 5 (instead of 3 and 4). The latter pair of numbers corresponds to the 1949 translation and, according to Mats Lundahl, to the original Swedish 1919 article as well.

economies under consideration could have different endowments but identical techniques, full employment, and positive levels of output.

The second problem emerges from a consideration of the competitive profit conditions of equilibrium in which costs are equal to commodity prices. Suppose the return to land,  $r_T$ , is arbitrarily chosen. Then for positive equilibrium production of the two commodities:

$$r_K + w = (p_1 - r_T)$$

$$3r_K + 4w = (p_2 - r_T)$$

where the return to capital and the wage rate are denoted by  $r_K$  and  $w$ , respectively. As for the commodity prices,  $p_i$ , not only must they both exceed  $r_T$  (to allow non-negative returns to the other two factors), but as well,

$$4(p_1 - r_T) > (p_2 - r_T) > 3(p_1 - r_T) > 0.$$

The dependence of the return to capital and the wage rate on given commodity prices and the return to land satisfying the above set of inequalities is shown by the solutions:

$$r_K = 4(p_1 - r_T) - (p_2 - r_T); \quad w = (p_2 - r_T) - 3(p_1 - r_T).$$

Figure 2 illustrates, by the intersection point of the two lines,  $D$ , a possible joint solution for the return to capital and the wage rate given commodity prices and the return to land with both commodities produced. The heavy broken line is the *factor-price frontier* for wages and the return to capital.

If the required inequalities are satisfied, can two economies that share this inflexible technology and face the same set of commodity prices have different factor endowments but end up with exactly the same factor returns without any international factor mobility being allowed? Yes. But *must* trade serve to equalize factor prices? No. For example,

in one country there might be a slightly lower return to land than in the other country, shifting upwards the pair of linear loci in Figure 2. Factor returns would thus be different in the two countries, with factor markets clearing in both and price equal to cost in both industries in each country.

Heckscher compounds his difficulties by suggesting (p.55) that in each country outputs adjust in the movement from autarky to free trade. This is not possible for a given set of factor endowments and rigid coefficients of production. Allowing smooth factor substitutability in both commodities would help in that factor prices could then change, and with them outputs of both commodities as techniques of production adjust. But the problem remains that the three-factor, two-commodity setting is not conducive to Heckscher's conclusion that factor price equalization will be complete. In fairness to Heckscher, however, he does leave himself some wiggle room. He later mentions a third commodity (with unit input-output requirements for land, capital and labor of 1,  $\frac{1}{2}$ , and 15, respectively) (see top p. 56), and earlier in his two-commodity illustration he does *not* state explicitly that these are the *only* two commodities produced. It was left to Samuelson and followers to point out more explicitly the balance between the number of factors and commodities required to get factor price equalization. As well, he does link factor-price equalization to the situation in which "techniques of production are the same in all countries," (p.54). If techniques were flexible, it would be the case that factor prices are uniquely linked to the techniques chosen, so that factor returns would be lined up between countries if, with trade, these techniques were the same. However, in his example the techniques were inflexible and *assumed* to be the same between countries, and this inflexibility disrupts the link between techniques and factor prices.

Another problem with the numbers chosen by Heckscher in his illustration is revealed by a closer analysis of Figure 2. In his discussion of how the United States and Europe differ in factor returns (pp. 58, 59), he stresses that land rents are low in the United States and thus wages are high – fostering immigration from Europe if international trade in commodities does not suffice to equalize factor prices. Would a country with the technology assumed by Heckscher experience an increase in labor’s wage rate if the return on land were to be reduced? Both loci in Figure 2 would be shifted upwards, but in such a way that the return to capital rises and *the wage rate falls*. To use more modern terminology, the reduction in land rents lowers the relative effective price in the second sector {i.e.  $(p_2 - r_T)/(p_1 - r_T)$ }, and the second sector is relatively labor intensive.

### **The 3 x 3 Case**

The objections raised above to the argument presented by Heckscher to establish the proposition that international trade suffices to bring equality of factor prices among countries even without any international factor mobility (as long as they share a common technology) cease to have relevance if the number of productive inputs is matched by the number of produced commodities, as in the 3x3 case. Even if production coefficients are rigid, alterations in the composition of commodity outputs *often* suffice to clear factor markets when factor endowments are altered, even without any change in factor prices. The qualification refers to the necessity (in order to clear markets) that the vectors of techniques for the three commodities contain the factor endowment vector. (In the 2x2 case this is stated as requiring the endowment vector to lie within the *cone of*

*diversification*<sup>3</sup> ). If so, two countries with different endowments would find their factor returns brought to equality with free trade. And Heckscher's argument would be even stronger if the common technologies were flexible in allowing techniques actually adopted to be sensitive to factor prices.

Even if technologies are flexible, there is no guarantee that in this 3x3 case a country will actually produce all three commodities in a free-trade equilibrium, although it could do so in the absence of international trade. Perhaps the most basic feature of trade is that it allows a country to consume many more commodities than it produces. In the present scenario a country might produce all three commodities, or perhaps just two or, indeed, may be specialized completely to the commodity in which it has the greatest comparative advantage. Two countries that share the same technology but have different factor endowments may thus very well produce different commodities, or perhaps have an overlap of a commodity produced in common with a commodity that is not. Heckscher was well aware of this possibility, and he stressed that in such a case factor returns would *not* be equalized by trade, any commodity produced in common would not have the same technique utilized in each country, and that international migration would result if allowed. He discussed this possibility in the context of trade between the United States and Europe (pp. 58, 59).

There is a reservation about trade and factor-price equalization that was not brought out explicitly by Heckscher, but was the focus of much of the literature some decades later. That reservation has to do with the possibility of *factor-intensity reversals*. This phenomenon is typically discussed in the 2x2 setting. Although a country's factor prices are usually assumed uniquely to determine productive techniques (i.e. no "flats" on the

---

<sup>3</sup> See John Chipman (1966).

isoquants) and thus the cost of production (equal to price in a competitive equilibrium in which the commodity is produced), uniqueness may not work in the other direction. That is, commodity prices may not uniquely determine factor prices. (An early discussion of this is found in Samuelson's factor-price equalization articles, 1948, 1949). A pair of countries might each produce the full complement of commodities (i.e. the same number as the number of factors), but their endowment vectors could lie in different cones of diversification. Although much of the mathematical literature concerned with the conditions for the univalence of the commodity price-factor price relationship pays no attention to factor endowments, trade theorists from Samuelson's 1948 article have always stressed that a necessary condition for factor-price equalization is that countries' endowments be fairly similar.

The questions most intensely debated in the literature concerning the 3x3 scenario have to do with the pair of "Heckscher-Ohlin propositions" not stressed by Heckscher, nor by Ohlin, *viz.* the Stolper-Samuelson Theorem (1941) and the Rybczynski Theorem (1955). Are there strong general results that can be stated for the effect of a commodity price change on the distribution of factor income or for the effect of endowment changes on the composition of output for a country facing given commodity prices? In a sense the answer is in the negative, in that more structural detail is required, having to do with factor intensity comparisons. For example, John Chipman (1969) showed that an increase in any commodity price would unambiguously raise the real return to the factor most intensively used in that sector if that factor's distributive share in that sector exceeded its share in the other two industries.<sup>4</sup> Heckscher did not explicitly concern

---

<sup>4</sup> In the same issue of the journal in which Chipman's contribution appeared, Murray Kemp and Leon Wegge (1969) provided even more strict conditions on factor shares that would suffice, in the 3x3 case, to

himself with either of these propositions. The Stolper-Samuelson kind of result rests heavily upon the assumption that productive activities are not joint. That is, in each a combination of inputs yields a unique individual output. The factor-price equalization result, I would argue, does not (Jones, 1992b).<sup>5</sup> Of course the Heckscher-Ohlin Theorem, discussing the relationship between factor endowments and trade patterns, is related to the Rybczynski type of theorem. In the 3x3 case Ed Leamer (1987 and 1994) has extensively explored possible relationships among physical factor endowments and trade patterns as well as trade and factor returns.<sup>6</sup> In this context it is useful to recall that Heckscher adhered to the price version of relative factor endowments.

### **The Holy Trinity and Many Commodities**

I have often maintained that Heckscher-Ohlin theory can best be seen (and is more easily understood) in the context in which many commodities can technically be produced. The reason for this is that with trade a country can be highly specialized, even to the extent of producing only a single commodity. Thus the interesting question can be raised: With trade, *what* commodities does a country produce? This is Ricardian in its tone. If world prices are not necessarily reflected in a country's own technology, the country need not produce more commodities than it has productive factors, and may produce an even smaller number. Thus if there are more commodities than three, there is much room for production patterns to differ among countries and for their factor returns

---

establish that an increase in any commodity price would raise the real return to the factor used intensively there and lower the returns to the other two factors. In both of these articles the criteria used to establish results in the 3x3 case were shown *not* to be sufficient in the 4x4 case. Sufficient conditions for each of these cases in higher dimensions were provided later in Jones, Marjit and Mitra (1993) and Mitra and Jones (1999)

<sup>5</sup> For a divergent view see Samuelson (1992).

<sup>6</sup> For agreements and disagreements with Leamer see Jones (1992a).

to be different even with commodity trade. The stage is set for a discussion of international mobility of productive factors, and Heckscher was very much involved with discussions of Swedish emigration. This is a setting in which Heckscher's unique and great role in trade theory can well blend in with his voluminous published work on economic history.

### **Concluding Remarks**

There is no doubt that Heckscher's 1919 article is a classic. Since its translation into English (thirty years after its publication) it became clear that Eli Heckscher's contribution to the modern theory of international trade (as it was then called) had to be put on a par with that of his brilliant student, Bertil Ohlin. Ohlin added more technical material, borrowing from Cassel (and, indirectly, from Walras), and, especially in his 1933 Harvard University Press volume, delved deeply into historical episodes as well as into the importance of economies of scale. (This was later picked up in so-called "new trade theory". See, for example, Paul Krugman's remarks, (1999)). In his earlier and shorter presentation, Heckscher also brought up the possibility that scale in production was important, and could lead to lower costs and better technology.

In retrospect perhaps the major difference in the contributions of these two Swedish economists concerned the effect of international trade on a nation's distribution of income. Although I have argued above that Heckscher's illustration of why factor prices might be fully equalized with trade is subject to reservations, he was absolutely clear that such a result was possible. In particular he was explicit on the fact that having factor prices brought to equality with trade would not signal the end of trade. Instead, trade

would merely have reached its equilibrium level and would not expand further (unless conditions changed). In this he was bolder than Ohlin, who, perhaps with a keen eye on actual trading conditions, was reluctant to accept that international trade by itself could bring about full equalization of factor returns. Heckscher remarked on the possible mobility of factors between countries in case countries were sufficiently dissimilar that trade would not equate factor returns. As well, he considered the case in which changes in factor returns would alter their domestic supply. In this he was correct in asserting that variable factor supplies would result in greater differences in factor endowments between countries as a consequence of trade (which would serve to lessen the possibility of factor price equalization).

I was first introduced to the English translation of Heckscher's article when Heckscher was still alive. As I recall, it was tough reading then, and remains so for me to this day. As Samuelson has remarked, both Heckscher and Ohlin missed the opportunity to spell out their model in simple terms, such as in the two commodity, two factor case that proved of such worth in countless succeeding articles and books. (But I am thankful for the great employment opportunities this provided to subsequent generations). I think this reflects the nature of the times. After all, which of the holy trinity of labor, capital and land could be denied, especially in a time and place in which each of these factors was deemed to be so important in production, especially by an economic historian. With the holy trinity maintained, Heckscher still did a remarkable job in laying out the foundations of what has since become known as Heckscher-Ohlin Theory.

## References:

- Batra, Raveendra and Francisco Casas (1976): "A Synthesis of the Heckscher-Ohlin and The Neoclassical Models of International Trade," *Journal of International Economics*, 6, pp. 21-38.
- Chipman, John S. (1966): "A Survey of the Theory of International Trade, Part 2", *Econometrica*, 33, pp. 685-760.
- \_\_\_\_\_ (1969): "Factor Price Equalization and the Stolper-Samuelson Theorem," *International Economic Review*, 10, pp. 399-406.
- Ellis, Howard, and Lloyd Metzler (eds.) (1949): *Readings in the Theory of International Trade*, Blakiston Press, for the AEA.
- Ethier, Wilfred (1974): "Some of the Theorems of International Trade with Many Goods and Factors," *Journal of International Economics*, 4, pp. 199-206.
- Flam, Harry and M. June Flanders (eds.) (1991): *Heckscher-Ohlin Trade Theory*, (MIT Press, Cambridge).
- Haberler, Gottfried (1936): *The Theory of International Trade*, (William Hodge & Co., London).
- Heckscher, Eli (1919): "The Effect of Foreign Trade on the Distribution of Income," *Ekonomisk Tidskrift*, pp. 497-512; reprinted and translated as ch. 13 in Ellis and Metzler, (1949) *op.cit.*; new translation in Flam and Flanders (1991), pp. 43-69 *op.cit.*
- Jones, Ronald W. (1956): "Factor Proportions and the Heckscher-Ohlin Theorem," *Review of Economic Studies*, 24, pp. 1-10.

- \_\_\_\_\_ (1971): “A Three-Factor Model in Theory, Trade and History,”  
in J. Bhagwati *et al* (eds.): *Trade, Balance of Payments and Growth*, (North-Holland,  
Amsterdam).
- \_\_\_\_\_ (1992a): “Factor Scarcity, Factor Abundance and Attitudes Towards  
Protection: The 3x3 Model,” *Journal of International Economic Integration*, 7,  
pp.1-19.
- \_\_\_\_\_ (1992b): “Jointness in Production and Factor-Price Equalization,”  
*Review of International Economics*, 1, pp. 10-18.
- Jones, Ronald W. and Stephen Easton (1983): “Factor Intensities and Factor Substitution  
in General Equilibrium,” *Journal of International Economics*, 15, pp. 65-99.
- \_\_\_\_\_, Sugata Marjit, and Tapan Mitra (1993): “The Stolper-Samuelson  
Theorem: Links to Dominant Diagonals,” in Robert Becker *et. al.*(eds.): *General  
Equilibrium, Growth and Trade II* (Academic Press), pp. 429-41.
- Kemp, Murray C. and Leon Wegge (1969): “On the Relation between Commodity Prices  
and Factor Rewards,” *International Economic Review*, 10, pp. 407-13.
- Krugman, Paul (1999): “Was it All in Ohlin?”, in Ronald Findlay, *et. al.* (eds.): *Bertil  
Ohlin: A Centennial Celebration*, (MIT Press, Cambridge).
- Leamer, Edward (1987): “Paths of Development in the Three-Factor n-Good General  
Equilibrium Model,” *Journal of Political Economy*, 95, pp. 961-99.
- \_\_\_\_\_ (1994): “Commemorating the Fiftieth Birthday of the Stolper-  
Samuelson Theorem,” in Alan Deardorff and Robert Stern (eds.): *The Stolper-  
Samuelson Theorem: A Golden Jubilee*, (University of Michigan Press, Ann  
Arbor), pp. 289-308.

- Leontief, Wassily (1953): "Domestic Production and Foreign Trade: The American Capital Position Re-examined," *Proceedings of the American Philosophical Society*, 97, pp. 332-49.
- Mitra, Tapan and Ronald W. Jones (1999): "Factor Shares and the Chipman Condition," in James Melvin *et. al.* (eds.): *Trade, Welfare and Econometrics* (Routledge, New York), pp. 135-43.
- Mundell, Robert A. (1957): "International Trade and Factor Mobility," *American Economic Review*, 47, pp. 321-35.
- Neary, J. Peter (1978): "Short-run Capital Specificity and the Pure Theory of International Trade," *Economic Journal*, 88, pp. 488-510.
- Ohlin, Bertil (1924): *The Theory of Trade* (Handelns Teory), in Flam and Flanders, *op.cit.* pp. 75-214.
- \_\_\_\_\_ (1933): *Interregional and International Trade*, (Harvard University Press, Cambridge).
- Rybczynski, T. (1955): "Factor Endowments and Relative Commodity Prices," *Economica*, 22, pp. 336-41.
- Samuelson, Paul A. (1948): "International Trade and the Equalisation of Factor Prices," *Economic Journal*, 58, pp. 163-84.
- \_\_\_\_\_ (1949): "International Factor-Price Equalisation Once Again," *Economic Journal*, 59: pp. 181-97.
- \_\_\_\_\_ (1971): "Ohlin was Right," *Swedish Journal of Economics*, 73, pp. 365-84.
- \_\_\_\_\_ (1992): "Factor-Price Equalization by Trade in Joint and Non-joint

Production,” *Review of International Economics*, 1, pp. 1-9.

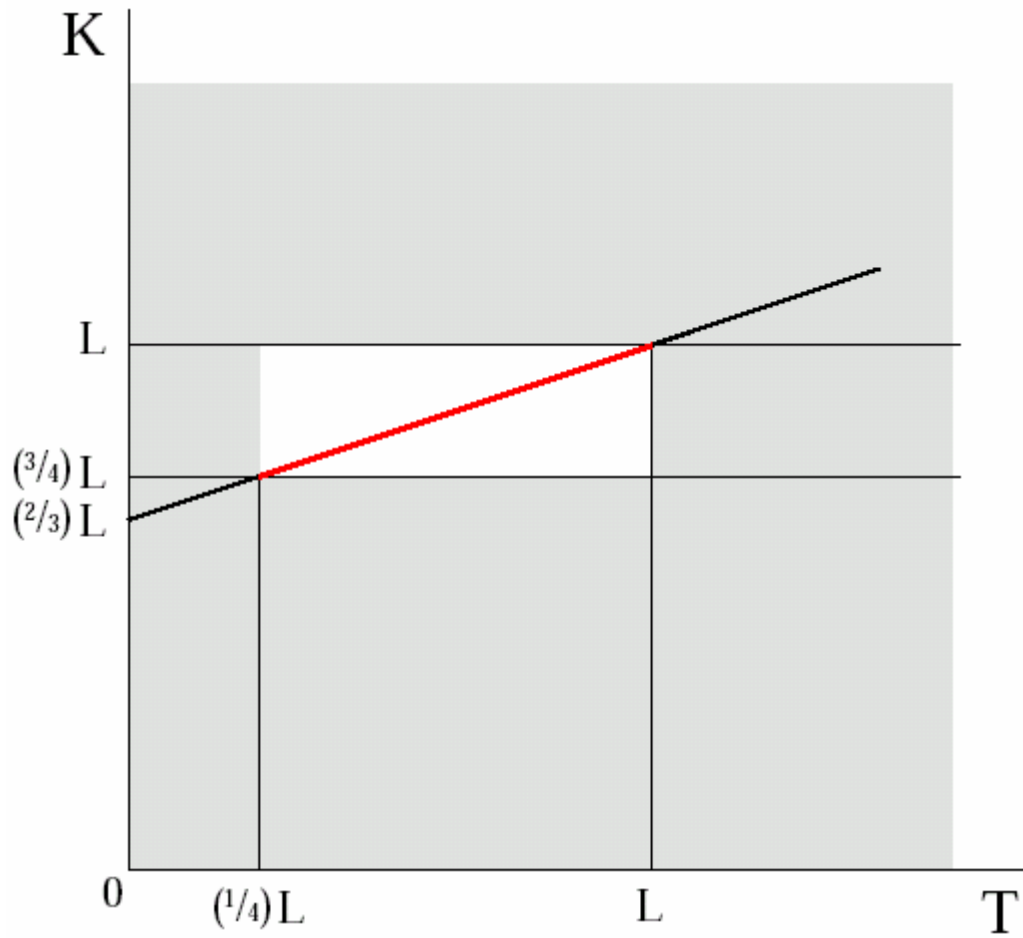
Stolper, Wolfgang and Paul A. Samuelson (1941): “Protection and Real Wages,”

*Review of Economic Studies*, 9, pp. 58-73.

Suzuki, Katsuhiko (1983): “A Synthesis of the Heckscher-Ohlin and the Neoclassical

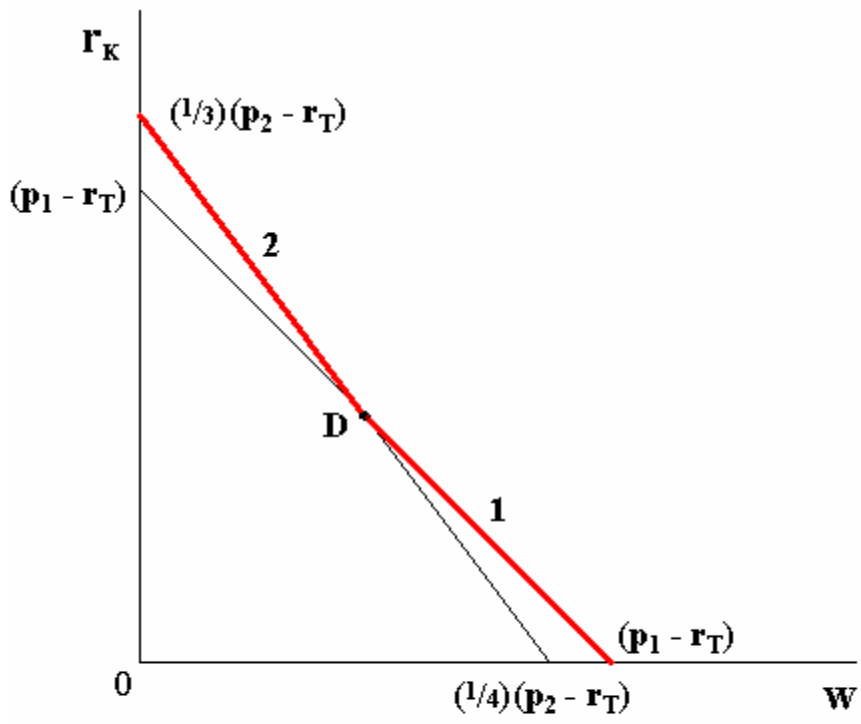
Models of International Trade: A Comment,” *Journal of International Economics*,

14, pp. 141-44.



**Figure 1: Allowable Endowments**

$$T = 3K - 2L \quad ; \quad \frac{1}{4}L < T < L; \quad \frac{3}{4}L < K < L$$



**Figure 2: Factor-Price Frontier**