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Heckscher-Ohlin Trade Flows: A Re-appraisal

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The famous Leontief paradox compared the factor proportions used in a country's export sectors with those used in that country's import-competing sectors in order to conclude whether a country was relatively capital abundant (in a two-factor, labor and capital setting). When examined in a two-factor, many commodity setting, this procedure reveals the troubling conclusion that as a country's relative capital endowment rises, its export sector relative to its import-competing sector cycles from being labor-intensive to being capital-intensive, to being labor-intensive, etc., which serves to invalidate the Leontief procedure.

JEL Codes: F10, F11
Key Words: Leontief Paradox, Factor intensities, Cycling behavior, Relative factor endowment ranking.

Few economics articles have had the impact created by Wassily Leontief's finding in 1953 that the United States international trade pattern seemed at variance with predictions supported by the models based on the work of Eli Heckscher (1919) and Bertil Ohlin (1933). According to his input-output data, United States exports were produced by more labor-intensive techniques than those used in American production activities that competed with imports, a comparison that seemed distinctly at odds with the pre-conceived notion that the United States was more capital abundant than almost all of its trading partners. Such a finding was bound to encourage many articles, both theoretical and empirical, that, in the words of Wilfred Ethier (1974), greatly enhanced our understanding of the relationship between factor endowments and the pattern of trade (formally, the Heckscher-Ohlin Theorem), which was one of the four basic theorems of Heckscher-Ohlin theory, the others being the Factor-Price Equalization Theorem, the Stolper-Samuelson Theorem (both antedating Leontief) and the Rybczynski Theorem (1955).

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Early work that more carefully analyzed the link between factor endowments and technology admittedly was based on the two-country, two-factor, two-commodity setting explored by Samuelson in his two factor-price equalization papers (1948, 1949). Subsequent analyses revealed the simplicity of the many-commodity, two-factor setting because with international trade the number of commodities a country might have to produce would notexceed the number of its productive factors. If factors were limited to capital and labor, a country's technology and the set of commodity prices ruling in world markets would yield a Hicksian composite unit-value isoquant, more colloquially described as the isoquant for "producing a buck" on world markets. Depending upon a country's factor endowment capital/labor ratio, such an isoquant would reveal either which single commodity would be the best to produce or, alternatively, which pair of commodities would be observed in a competitive trade equilibrium. It is this setting I will use in criticizing the standard interpretation of the Heckscher-Ohlin Theorem whereby a ranking of factor intensities in export and import-competing activities within a country reveals evidence of capital/labor endowment rankings.

Figure 1 illustrates a Hicksian composite unit-value isoquant in the four-commodity case in which the country's technology would allow production of any of the four commodities at the given commodity prices if factor endowment proportions were appropriate. Factor endowment rays that would intersect the tangent chords, AB, CD, or EF correspond to situations in which the country produces a pair of commodities. It proves convenient to transcribe this information into Figure 2. Given the country's technology, the rising curve for each commodity depicts the capital-labor ratio (on the horizontal axis) that would be employed for various levels of the ratio of wages to capital rentals (on the vertical axis).

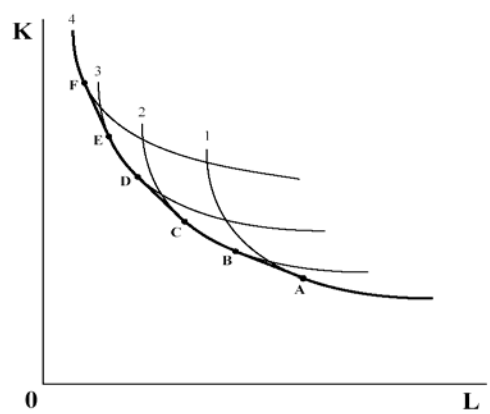

Fig. 1 The Hicksian Composite Unit Value Isoquant

The pattern of production for any factor endowment proportions depends upon world prices, and in Figure 2 the set of given prices determines the heavier locus that combines the possibility that complete specialization occurs (along a rising curve for a single commodity)

with "flats" connecting a pair of such curves, and along which production of a pair of commodities takes place and the factor price ratio is completely determined. Thus if a country with a given technology should develop as the capital/labor endowment ratio grows, its production pattern would systematically alternate between producing a single commodity and producing a pair, and the composition of production would change as long as commodity prices remain the same. Alternatively, comparisons could be made between a pair of countries that differ in their endowment ratios but face the same world prices. It was this latter question that revealed that factor prices could be equilibrated between two such economies if their endowment proportions were not too far apart.

For each "flat" in Figure 2 three regions have been identified. For illustrative purposes concentrate on the middle flat along which the country produces commodities 2 and 3. Regions II are those in which production of each commodity (2 or 3 for the middle flat) is sufficiently great that both commodities are exported. However, in such Regions there is no "import-competing" activity – with imports consisting only of commodities (1 and 4 in the middle flat) that are consumed but obtained in full by imports from the rest of the world. Similarly, if only a single commodity is produced, there is obviously no import-competing local activity. Such is not the case, however, in Regions I and III. For the middle flat in Region I, i.e., for a country whose capital/labor endowment proportions allow only small levels of production of the third commodity, local consumption requires as well some imports of the third commodity from the rest of the world (with commodity 2 being exported). For higher capital/labor endowment ratios, such that production takes place in its Region III, the asymmetries in production and trade are reversed. For Region III of the middle flat the country exports the third commodity and imports the second, along with the first and fourth commodity that is does not produce.

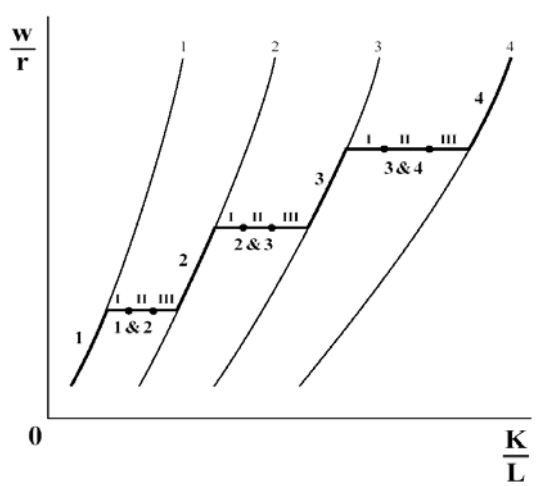

Fig. 2 Factor Endowments and Factor Prices

Now consider a pair of countries (call them Home and Foreign) that share the same technology and face the same commodity prices, but have different factor endowment proportions. Suppose Home is relatively labor abundant, and producing in Region III in the first flat, i.e. producing and exporting commodity 2 and importing (and also producing) commodity 1. By contrast, Foreign is sufficiently capital abundant that it produces commodities 3 and 4 in Region I of the highest flat. The relatively labor- abundant Home country exports commodity 2, which is relatively capital intensive compared with its import-competing commodity 1. Compare this with the relatively capital-abundant Foreign country, a country that exports its relatively labor-intensive commodity (3) whereas its more capital-intensive commodity produced (4) must be imported because local production is too limited. To summarize: the relatively labor-abundant Home country exports its relatively capital-intensive commodity and the relatively capital-abundant Foreign country exports its relatively labor-intensive commodity. This would violate the form of the Heckscher-Ohlin Theorem that predicts a comparison of techniques within a country between its exporting and import-competing sectors from the ranking of relative factor endowments.

Earlier literature (e.g. Jones, 1956) pointed out a pair of possibilities that could explain the failure of the Heckscher-Ohlin Theorem. The first is the case of technological "factor-intensity reversal" that, in Figure 2, would be illustrated if a pair of the rising curves indicating factor intensities selected at various factor prices, intersected. Here I have explicitly avoided that technological reversal phenomenon. The second is the case in which demand patterns are strongly asymmetrical in the two countries, with, say, the labor-abundant country having such a biased demand in favor of its labor-intensive commodity that it makes use of trading possibilities to import this commodity. Here demand conditions could be the same between countries and balanced among commodities (say equal shares in a Cobb-Douglas setting).

Note that as a country is placed in a growth context, with increases in its capital/labor endowment proportions, it systematically switches from exporting its labor-intensive commodity to exporting its capital-intensive commodity and then switching back to exporting its labor-intensive commodity, with each switch interrupted by periods of growth in which there is no import-competing production (either both produced goods are exported or the country is completely specialized). Imagine a set of countries with different factor endowments but sharing access to the same technology and facing the same commodity prices. It would be natural *not* to find a consistent positive ranking between capital/labor endowment proportions on the one hand, and intra-country factor intensity rankings, on the other. In this multi-commodity setting the use of intra-country intensity rankings to deduce relative factor abundance is inappropriate.

Notwithstanding the questionable Leontief intra-country ranking, there are two observations that do serve to connect a country's factor endowments to the relative capital intensity of its exports. First of all, a country will tend to produce commodities that require for their production factor intensities fairly similar to those found in its endowment bundle, and tend to import commodities which, if produced at home, would reflect both higher and lower

capital/labor ratios than the commodities actually produced at home (Jones, 1974). Secondly, a comparison of two countries that share the same technology but do not produce exactly the same bundle of commodities reveals that every commodity produced by the capital-abundant country uses techniques that are more capital intensive than those used by the labor-abundant country in any commodity.

Given the duality in trade theory between relationships involving factor endowments and commodity outputs on the one hand and factor prices and commodity prices on the other (e.g. Jones, 1965a, 1965b), it is instructive to consider a case such as would be illustrated in Figure 2 by considering Home producing in the middle flat, with Foreign producing in the highest flat. Both countries produce a commodity (3) in common. However, it is *not* a violation of Heckscher-Ohlin theory to observe that an increase in the price of the commonly produced commodity (3) would raise the relative wage in one country and lower it in the other. Perhaps more surprising is that the country in which the wage rate would increase is the relatively capital abundant Foreign country. If the relatively labor-abundant Home country produces in Region I (of the middle flat), and has imposed a tariff on imports of commodity 3 from the capital-abundant Foreign country (producing in Region I of the highest flat), a movement towards freer trade (in commodity 3) would serve to raise the wage rate in both countries. In a multi-country version these results do not contradict Heckscher-Ohlin theory.

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