The Leontief Paradox: Continued or Resolved?

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Comment

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I
An important corollary of the Heckscher-Ohlin-Vanek model of international trade is that under balanced trade a country will be a net exporter of the services of its abundant factors and a net importer of the services of its scarce factors, where abundance and scarcity are defined in terms of a factor-price-weighted average of all resources. Thus, if $K_x$ and $K_m$ denote the amounts of capital services embodied in exports and imports, respectively, and $L_x$ and $L_m$ the corresponding amounts of labor services, then $K_x > K_m$ and $L_x < L_m$ if capital is abundant and labor is scarce, implying that $K_x/L_x > K_m/L_m$.

However, even under balanced trade conditions it is not possible to infer relative resource abundance from the observed factor intensity ranking of traded goods when two factors are exported or imported simultaneously, as was the case for the 1947 U.S. data used by Leontief (1954) in his famous study. Those data revealed that the United States had been a net exporter of the services of both capital and labor, and Leamer (1980) has clearly demonstrated that such a situation is compatible with either ordering of capital and labor abundance. However, Leamer was able to establish conclusively that Leontief's data together with information on the supplies of capital and

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labor implied that the United States had been revealed to be abundant in capital compared to labor.

Leamer’s argument did not address the question of whether the positive net exports of labor services by the United States could be taken as an indication of labor abundance relative to all resources on the average. Had U.S. foreign trade been balanced in 1947 the answer to this question would be unambiguously positive, but as we demonstrate in the next section it is not possible to uniquely link resource abundance or scarcity with the sign of the net export flow of factor services in the presence of a trade surplus or deficit. One solution to this difficulty is to compute the factor services embodied in the net commodity exports that would have been observed under balanced trade conditions. Such calculations are made difficult by the fact that the commodity composition of a country’s trade would necessarily be different under those conditions, but the Heckscher-Ohlin-Vanek model implies a very special and predictable change in this composition. These calculations are shown in Section III, and they reveal that the United States would have been a net importer of labor services under balanced trade, a result that sharply contrasts with Brecher and Choudhri’s (1982) suggestion that trade balance would have left the United States a net exporter of labor services. The note concludes by indicating that another paradox outlined by Brecher and Choudhri remains unsolved.

II

Consider a model with $m$ commodities and $n$ factors, internationally identical and linearly homogeneous production functions, internationally identical and homothetic consumer preferences, complete international factor price equalization, and perfectly competitive product and factor markets. With $Y_i$ and $Y_w$ denoting the domestic and world income levels, let $\beta_i = Y_i/Y_w$ measure country $i$’s relative share of world income.

While under balanced trade aggregate domestic absorption equals income, the two differ in the presence of a surplus or deficit. Since world absorption and income are identically equal, the relative share of country $i$ in world absorption, $\alpha_i$, is given by

$$\alpha_i = \frac{C_i}{C_{iw}} = \beta_i \left( \frac{C_i}{Y_i} \right),$$

where $C_i$ and $C_{iw}$ are the levels of absorption in country $i$ and the world.

In a multifactor world it is convenient to adopt the definition of factor abundance proposed by Williams (1970), which states that
country \( i \) is abundant (scarce) in resource \( I = L, K, \ldots \) if the ratio of its endowment of that factor, \( I_i \), to that of the world, \( I_w \), exceeds (falls short of) the ratio of the country’s income to world income, that is, if \( I_i/I_w > (<) \beta_i \).

As Brecher and Choudhri (1982) have shown, the amount of services of factor \( I \) embodied in country \( i \)’s net exports, \( I_i \), may be written as

\[
I_i = I_i \left[ 1 - \left( \frac{\alpha_i}{I_i} \right)^2 \right]
\]

or, using (1),

\[
I_i = I_i \left[ 1 - \left( \frac{C_i}{Y_i} \right) \frac{\beta_i}{I_i} \right].
\]

This expression implies that under balanced trade, \( C_i = Y_i \), country \( i \)’s net exports of factor \( I \) services are positive (negative) if and only if that factor is abundant (scarce); that is, \( I_i \geq 0 \) if and only if \( I_i/I_w \geq \beta_i \). However, when trade is not balanced it is possible for a deficit country, \( C_i > Y_i \), to import the services of an abundant resource or conversely for a surplus country, \( C_i < Y_i \), to export the services of a scarce factor. It follows that the export of labor services by a surplus country does not constitute evidence of labor abundance, nor do such exports contradict a hypothesis of labor scarcity.

Although the actual signs of the indirect net resource flows may not be an accurate indicator of factor abundance, it is possible to infer the latter by computing the hypothetical balanced trade flows of factor services from existing trade data. The assumption of internationally identical and homothetic consumer preferences implies that a trade imbalance does not affect the commodity composition of world demand and, hence, commodity prices and supplies. However, an imbalance would decrease (increase) the demand for all goods and consequently the derived demand for all factors equiproportionately in country \( i \) if that country has a trade surplus (deficit) in comparison with the balanced trade state. If \( I^*_i \) denotes the amount of factor \( I \) services embodied in domestic absorption under balanced trade and \( I^*_i \) the corresponding amount embodied in actual absorption, then

\[
I^*_i = \left( \frac{Y_i}{C_i} \right) I_i.
\]

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1 In the two-factor case this definition coincides with the familiar physical definition of relative factor abundance since, e.g., capital abundance would be defined as \( K_i/K_w > Y_i/Y_w = (W_K K_i + W_L L_i)/(W_K K_w + W_L L_w) \), where \( W_I \) is the price of factor \( I \). It is readily seen that this inequality holds if and only if \( K_i/K_w > L_i/L_w \).
It follows that the net amount of services of factor 1 that would be exported under balanced trade is given by

\[ I_1^* = I_1 \left[ 1 - \left( \frac{Y_i}{C_i} \right) \left( \frac{L_i}{I_i} \right) \right], \]  
(5)

so that

\[ I_1^* \geq 0 \text{ if and only if } \frac{C_i}{Y_i} \geq \frac{L_i}{I_i}. \]  
(6)

This expression reveals that a country with a trade imbalance would have been a net exporter of the services of factor 1 under balanced trade, and the country would therefore be revealed abundant in that factor, if the ratio of domestic consumption to endowment of the factor is smaller than the ratio of domestic absorption to income, and vice versa.\(^2\) Such a test has the significant advantage of relying exclusively on domestic data.

III

Leontief’s (1954) data show that U.S exports in 1947 amounted to $16,678.4 million while imports were $6,176.7 million. His figures also show that with exports using 182,313 man-years and import replacements using 170,004 man-years per million dollars, the United States had indirectly exported 1,990,795 man-years of labor services more than it had imported. Given the Travis (1964) estimate of the U.S. labor endowment of 47,273,526 man-years, the ratio of labor embodied in domestic absorption to domestic endowment is thus 0.95788. This can be compared with the ratio of domestic absorption to domestic income of 0.94714 based on the Woytinsky and Woytinsky (1953) estimate of the U.S. national income of $198,688 million together with Leontief’s export and import figures.

It follows from our earlier discussion that if U.S. trade had been balanced, labor services would have been imported and the country’s labor scarcity would have been directly revealed. Specifically, equation (5) yields an estimate of 536,453 man-years for the hypothetical balanced trade level of net imports of labor services. It may thus be asserted that the Leontief paradox in terms of the indirect factor trade version of the Heckscher-Ohlin-Vanek theory can be satisfacto-

\(^2\) It should be observed that by increasing or decreasing the demand for all goods and for all factors equiproportionately, a trade imbalance will not alter \(I_i/C_i\), which will thus remain equal to \(I_i/C_i = I_i/Y_i\) regardless of whether trade is balanced or not. Together with the definition of factor abundance, this provides an alternative derivation of eq. (6), which was suggested by Edward E. Learner.
rily explained within the framework of that theory rather than by relaxing some of its fundamental assumptions.

Moreover, the conventional Leontief paradox of relatively capital-intensive U.S. import replacements can also be explained in terms of the trade surplus rather than in terms of the factor multiplicity invoked by Leamer (1980). Equation (5) yields an estimate of $6,426 million for exports of capital services under balanced trade compared with their actual value of $23,450 million. With the United States a net capital exporter and labor importer, the balanced trade figures thus reveal U.S. exports to be characterized by a higher capital-labor ratio than its import replacements.

IV

While our analysis suggests that adjusting Leontief’s data to eliminate the influence of the trade surplus will resolve the Leontief paradox whether in terms of the factor intensity ranking of traded goods or in terms of the net export of labor services, the data also reveal another paradox, which cannot be explained within the framework of the relative factor endowment theory.

By definition, if resource I is scarce in a country, domestic income per unit of that factor will be larger than the world level, and vice versa. However, while equation (3) shows that such a scarce factor may be exported in the presence of a surplus, equation (2) indicates that the assumptions of the Heckscher-Ohlin-Vanek model imply that domestic absorption per unit of an exported resource—whether abundant or scarce—will be lower than the world level.

Available evidence such as Denison’s (1967) data suggests that both income and absorption per worker in the United States were considerably higher than in its major trading partners even though labor services were exported. This inconsistency cannot be regarded as a modified version of the Leontief paradox as suggested by Brecher and Choudhri (1982), since it does not concern the relationship between factor abundance in the United States and its pattern of commodity and/or indirect factor trade. But this inconsistency confirms that Leontief’s data reveal the existence of some departures—international differences in technologies are a leading candidate—from the strict assumptions of the Heckscher-Ohlin-Vanek model.

In other words, the model predicts that absorption per worker will be lower domestically than worldwide if labor services are exported, whether or not these exports are consistent with the assumed factor abundance.
References