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## Undergraduate Essay Contest Winner

# Resource Endowments and Anomalies in International Trade Patterns: A Study of India, Japan and the U.S.A.

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### Introduction

The pure theory of international trade, in its most elementary form, is predicated on differences in resource endowments between different countries. It has been argued, most notably by the Swedish economist Bertil Ohlin, that the existence of such inter-country differences in resource endowments explain the comparative cost differences between the factors of production, and hence the prevalence of trade. In the mid 1950's though, W. W. Leontiev's findings with regard to the nature of U.S. trade gave rise to considerable controversy because of the paradoxical nature of the findings. In this paper, the findings of Leontiev are examined and the seemingly anomalous trade patterns of India and Japan are also explored. It will be seen that while the Heckscher-Ohlin Theorem (to be explained) still holds, resource endowments in themselves are never a complete explanation of trade patterns.

The purpose of W. W. Leontiev was to test the standard Heckscher-Ohlin Trade Theorem. The Heckscher-Ohlin Trade Theorem says that when (A) perfect competition prevails, (B) production functions are similar for the same commodity in both the countries and are different for different commodities, (C) production functions are homogenous and of degree one, (D) the production functions are distinct technologically, i.e. commodities can be distinguished by factor intensity, (E) factors are given and employed fully, (F) there is complete free trade and transport and all other costs are zero, and (G) preference functions i.e. demand preference functions are similarly shaped in both the countries; then in such a scenario, "every country tends to export those goods that use its relatively abundant resources relatively intensively, and tends to import those goods that use its relatively scarce resources relatively intensively." (Richardson, p. 393)

Leontiev attempted to test this theorem with the help of an input-output table for the United States for the year 1947. He assumed that the U.S.A.

decreased "its production of exports and imports by an equal amount, \$1 million." This could be achieved in several ways such as trade tariffs, import quotas etc. With the above assumption, Leontiev set out to determine what effect the above change in product would have on the factors of production, of which he considered only two, i.e. labor (L) and capital (K). Now when exports decline, both the factors of production, i.e. labor and capital, are set free. Also when the production of import-competing goods is increased, greater amounts of labor and capital are needed. Now, "if, as is commonly assumed, the United States is a capital abundant nation, the Heckscher-Ohlin model yields the hypothesis that the reduction in export production will release more capital and less labor than will be absorbed by the increase in import-competing goods production." (Freeman, p. 114) Leontiev's empirical findings however ran contrary to expected beliefs in that, "the postulated shift from export production to import competing production released more labor than was being absorbed and relatively less capital than could be absorbed. (Freeman, p. 114) What this meant was that the U.S.A. tended to export labor intensive goods and import capital intensive goods. Because of the paradoxical nature of the empirical findings with respect to the widely accepted Heckscher-Ohlin Trade Theorem, the experimental findings soon came to be known as the "Leontiev Paradox."

Several explanations have been offered to explain the paradox. In this connection, I shall briefly highlight four such explanations for the U.S.A. (A) It is possible that U.S. labor is so much more productive w.r.t. labor in other countries that in terms of effective labor, the U.S. is actually labor abundant (Leontiev, 1956). (B) The U.S.A. may have a very strong demand bias for capital intensive goods, with the result that exports do not agree with resource endowments. (Robinson) (C) Tariffs and other trade barriers can substantially alter the pattern of trade such that the true factor endowments are not reflected, because of the distorting effects of trade barriers. (Travis) (D) The fact that a sizeable portion of U.S. imports are from U.S. manufacturers who manufacture their goods abroad has complicated the trade scenario somewhat. These goods,

although manufactured abroad where labor is cheaper, are manufactured in a capital intensive fashion. When these capital intensive goods are imported by the U.S.A., the pattern of U.S. imports becomes substantially capital intensive. These international capital flows could be an explanation of the Leontiev Paradox. (Diab)

The above are some explanations for the Paradox with respect to the U.S.A. We now turn to the case of India and then Japan, wherein an attempt is made to study and analyze the findings of the existence of a similar Leontiev type Paradox in the two countries.

## India

With regard to India, the only definitive work to my knowledge to test the validity of the Heckscher-Ohlin Trade Theorem has been carried out by R. Bharadwaj (1962). Bharadwaj tests the hypothesis that "Indian exports to the U.S. absorb in their production relatively more labor than her competitive imports from the United States, which if produced at home (in India) would require relatively more capital." (Bharadwaj, 1962, p. 105) The opposite of course was assumed to be true for the U.S.A.

The 1947 import-export table for the U.S.A. and the inter-industry Transactions Table for 1953-54 for India formed the basis of this study. The study was carried out as follows. First, the detailed commodity-wise trade figures for the U.S.A. were obtained from the U.S. Department of Commerce regarding exports and imports. Then these figures were classified in accordance with the different sectoral classifications that had been adopted for the two input-output tables. Finally, further adjustments were made to the values for price changes, distributive margins from exports were removed, and the value of imports were converted to producer values. All this was done for the U.S.A. and India, so as to make the data compatible with the definitions that had been adopted for the respective input-output tables.

Next, two composite commodity vectors were derived for the U.S.A. using a crore rupees worth of Indian exports and imports and a million dollars worth of U.S. exports and imports. Then the factor contents were calculated and the actual input-output analysis was carried out. The final results of the studies are shown in Table 1.

The findings for the U.S.A. are in conformity with what one would generally expect, i.e., U.S. exports to India are primarily capital intensive and U.S. imports from India are relatively more labor intensive. But what is of interest here is the pattern of India's bilateral trade with the U.S.A. Contrary to what one would expect, we find that Indian exports to the U.S.A. are relatively more labor intensive. How can we explain this rather anomalous Leontiev-like paradox? It is this very question that I shall now attempt to answer.

**Table 1. Capital and Labor Requirements of Exports and Competitive Imports in 1951**

*One Million Dollars Worth of U.S. Exports to India and Competitive Imports from U.S. in 1951 (at 1947 prices):*

	Exports	Competitive Imports
Capital (dollars in 1947 prices)	3,002,428	1,770,456
Labor (man-years)	144.76	155.23

*One Crore Rupees Worth of Indian Exports to U.S. and Competitive Imports from U.S. in 1951 (at 1953-54 prices):*

	Exports	Competitive Imports
Capital (Rs in 1953-54 prices)	10,481,883	9,552,619
Labor (NO)	12,185	14,436

Source: Bharadwaj, 1962, p. 109.

The results (for both countries) are for 1951. Now as is commonly known, India has been and continues to remain an agricultural nation in essence. Within the large agricultural sector of India, good harvests and yields are greatly dependent on climatic patterns, particularly the amount of rainfall received by the different intensely cropped areas. As a result of unfavorable climatic conditions and other calamities, foodgrain output declined to levels considerably below estimates. This necessitated larger food imports. And because "agriculture is relatively more labor intensive in India, the overall labor requirements of the competitive imports bundle might have been somewhat upwardly biased." (Bharadwaj, 1962, p. 109) However, as Bharadwaj himself notes, this is only a partial explanation because food imports from the U.S.A. have continued to figure in the Indian import bill, and food imports for 1951 have not been appreciably higher than other years.

Another aspect of the study which deserves some mention is the different methods employed in calculating labor requirements for the U.S.A. and India. While for the U.S.A. the units are man-years, the units for India are the number of men employed. This difference is potentially significant because of the problem of high levels of disguised unemployment in the Indian economy. The particular problem with regard to disguised unemployment is that it affects (in a big way) only the primary (agricultural) sector of the economy. Because of this phenomenon, it is most likely that "the labor requirements of . . . exports and import replacements with differing sectoral compositions . . ." have been affected differentially. (Bharadwaj, 1962, p. 110) This could be an explanation of the relatively labor abundant nature of Indian imports from the U.S.A.

It is also quite possible that this study underestimated the capital requirements of Indian imports, particularly for engineering and chemical goods. This would be the case with regard to the above two

items in imports because engineering and chemical goods were rather "heavily aggregated in the Indian table comprising both . . . heavy and light manufacturers . . ." (Bharadwaj, 1962, p. 110) When this is done, capital underestimation is very likely in the calculation of the import commodity vector, which I have alluded to above. Similarly, in the export segment, "the somewhat prominent position of ores and minerals, bearing a comparatively high capital intensity in the Indian context, perhaps partially explains the higher capital requirements of Indian exports." (Bharadwaj, 1962, p. 110)

Thus with respect to India, along with the climatic and disguised unemployment factors, the major cause of the paradox seems to be the diverse production techniques which clearly violate "the assumption of similarity of production structure." (Bharadwaj, 1962, p. 110) With respect to production, let me address two other issues. First, when we consider LDC's like India the notion of production functions with constant returns to scale almost never seems to be true. Since this is one of the assumptions of the Heckscher-Ohlin trade theorem we can expect considerable divergences from the theoretical predictions of the Heckscher-Ohlin model. Second is the derivation of homohypallagic or constant elasticity of substitution (C.E.S.) production functions. When estimating this production function, it has been found that factor intensity reversals are quite common, "because the elasticity of substitution differs between industries . . . these factor reversals occur . . . in such diverse countries as the United States and India." (Minhas, 1963, p. 105) This yet again tells us that in reality the Heckscher-Ohlin Theorem assumption of no factor intensity reversal may not hold. If this is true, then we can expect paradoxes of the Leontiev type quite frequently.

We have so far considered the bilateral trade of India with the U.S.A. Let us now briefly consider the overall pattern of Indian trade. In a different study by Bharadwaj, it has been seen that the structure of Indian trade on the whole does seem to conform to the generally expected pattern of labor intensive exports and capital intensive imports. (Bharadwaj, forthcoming) "The inclusion of human capital as a major determinant of the commodity structure of trade was recognized by Leontiev and later became a prime focus in empirical implementation of the Heckscher-Ohlin model." (Kennan, p. 12) For India measures of human capital have been calculated, "based on wage differentials and on the returns to physical capital, human capital and unskilled labor." (Kennan, p. 14) When human capital and physical capital were combined, studies have shown that on the whole Indian exports were labor intensive in relative terms. (Bhagwati and Bharadwaj)

What is important to note in concluding this section is that "the statistical findings derived for a single trade partner and those for the world as a whole do not agree with one another." (Bharadwaj,

1962, p. 113) In the next section of the paper, it will be shown that this is true for Japan as well. Studies for Canada too have shown the above postulate to be true (Wahl). This does seem to indicate that a study involving only two countries, "does not give a sufficient enough basis to draw meaningful conclusions regarding situations." (Bharadwaj, 1962, p. 113)

## Japan

The study of Japan will be based primarily on the pioneering work of Masahiro Tatamoto and Shinichi Ichimura with respect to factor proportions and foreign trade. (Tatamoto and Ichimura) The inspiration for the study seems to have been W. W. Leontiev's following statement: "A comprehensive two-sided explanation of our economic relationship with the rest of the world will not, of course, be possible before the internal economic structure of at least one of the most important of our trading partners has been studied as fully as that of our own" (Tatamoto and Ichimura, p. 442-43), which he made at the conclusions of his first study of the U.S. trade structure. (Leontiev, 1954)

The main purpose of the paper is "to present . . . an input-output analysis of Japanese foreign trade and related problems." (Tatamoto and Ichimura, p. 443) Like the Indian study, this study too uses input-output analysis to determine the capital and labor requirements per million yen of exports and of competitive imports. Very briefly, the input-output system used is:

$$(I - A)(x) = (b)y - (c)z + (r)$$

where

- A = matrix of input coefficients,
- I = unit matrix,
- x = a column vector of output in million yen,
- b = a column vector of export coefficients defined as each sector's imports per million yen of total exports,
- c = a column vector of competitive import coefficients defined as each sector's imports per million yen of total competitive imports.
- y = total value of exports in million yen,
- z = total value of competitive imports in million yen, and
- r = a column vector of residuals of final demands.

In this system, x is the subject of the formula. The result of the computations are shown in Table 2.

According to the results in Table 2, Japanese exports include more capital and less labor than would be required for the domestic replacements of competitive imports of an equivalent amount. This tells us that Japanese exports are relatively capital intensive and imports relatively more labor intensive, in the context of bilateral trade with the U.S.A. Thus we have a seeming Leontiev-like paradox for Japan, too.

**Table 2. Capital and Labor Requirements Per Million Yen of Exports and of Competitive Import Replacement**

	<i>Capital (a)</i> (1951 Yen) (1947 Dollars)	<i>Labor (b)</i> (Man-Years)	<i>a/b</i>	<i>(c)</i>
Japan 1951				
Exports	1,385,780	5.520	251,047	
Competitive Imports	1,330,926	8.233	161,657	0.644
U.S.A. 1947				
Exports	2,550,780	182.313	13,992	
Competitive Imports	3,091,339	170.004	18,184	1.300

Source: Tatemoto and Ichimura, p. 443.

This paradoxical finding can be explained partly by recognizing the fact that the position which Japan occupied in the world at the time of the study was clearly midway between the developed and underdeveloped nations. What does this indicate? From what we have said above, it would not seem illogical to hypothesize that Japan is relatively capital abundant in comparison to countries less developed. On the other hand, with regard to more developed countries like the U.S.A., Japan could be expected to occupy a relatively labor abundant position. Tatemoto and Ichimura have tested this hypothesis with the help of then available data, and the results were as shown in Table 3. Comparing the two sets of results in Table 3, we can see that the capital-labor ratio of Japanese exports to the U.S.A. is lower than the figure for her total exports. This would seem to "imply that Japan exported less capital intensive goods to the United States, . . . and relatively labor intensive goods to countries other than the United States." (Tatemoto and Ichimura, p. 446) This supports the viewpoint that Japan's trade is distinctly dualistic in nature.

We have made a case for the dualistic nature of Japan's overall trade pattern which is "consistent with the Heckscher-Ohlin hypothesis, if, as is commonly supposed, Japan is labor abundant relative to the United States but capital abundant relative to her less developed trading partners." (Freeman, p. 115) Thus a careful analysis in this fashion does cause the paradox to disappear. But can we explain the paradoxical nature of U.S.-Japan trade without considering the dual aspect of Japanese trade? We can do so by considering factor intensity reversals in concert with the part played by natural resources. (Naya) In Japan, the major resource intensive sector, i.e. agriculture, is indeed subject to factor intensity reversals. Rice is very labor intensive in Japan and very capital intensive in the U.S.A. Now Japan, which is a labor intensive country with respect to the U.S.A., exports goods "that are more capital intensive than are her import-replacements." (Caves and Jones, p. 203) But the imports are primarily foodstuffs which

would be labor intensive if produced in Japan. These imports of food give the distinct labor intensive nature to Japanese imports. We can conclude by saying that if Japan did not import such vast quantities of foodstuffs, then her imports would have been capital intensive to a far greater degree. "This apparent reversal of factor intensities between agriculture and other sectors helps to reconcile the plentiful paradoxes found . . ." (Caves and Jones, p. 203)

With respect to Japan, we may note the distinct change in the pattern of trade over time. In the 1950's Japan specialized in the manufacture of goods which required large quantities of unskilled labor such as toys and textiles. With the passage of time, however, the Japanese have begun to specialize in the manufacture of products which are highly capital intensive. As a result a very interesting test to perform would be a Leontiev-type input-output analysis for the U.S.-Japan bilateral trade for the 1980's. The capital position with respect to abundance may well have changed in favor of Japan. Also Japan seems to be "quality of labor" abundant with regard to the U.S.A. I am inclined to believe that these two aspects have probably given Japan the edge with the result that the situation of Japan's exports being more capital intensive than the U.S.A.'s, would not be paradoxical anymore. Until

**Table 3. Capital-Labor Input Ratio for Japanese-American Trade**

	<i>Capital (a)</i>	<i>Labor (b)</i> (In Man-Years)	<i>a/b</i>
Japan's exports to the U.S.	1,026,387 (1951 Yen)	18.8839	54,352
U.S. exports to Japan	2,741,786 (1974 Dollars)	141.2169	19,415

Source: Tatemoto and Ichimura, p. 445.

an actual test is performed though, this issue remains a matter of pure conjecture.

## Conclusion

In this paper, I have attempted to bring out and analyze the anomalies in the pattern of India and Japan's bilateral trade with the U.S.A. and the overall nature of trade. I have shown how the seeming "paradoxes" can be resolved within the broad framework of the Heckscher-Ohlin Trade Model. In this connection, I may add that there are no paradoxes per se in the empirical studies. The fact that the findings have been considered to be paradoxical is indeed strange. Why? This is because resource endowments between different countries are just "one of the several fundamental determinants of trade patterns." (Richardson, p. 392) As a result they in themselves are definitely not sufficient to explain trade patterns. When all or several of the different fundamental factors affecting trade have been considered together as Bhagwati and Bharadwaj have attempted to do for India, the so-called paradoxes have appeared only on rare occasions. (Richardson, p. 392)

## References

- Bhagwati, J. N., and R. Bharadwaj, "Human Capital and the Indian Pattern of Foreign Trade," *M.I.T. Working Paper #57* (1970).
- Bharadwaj, R. "Factor Proportions and the Structure of Indo-U.S. Trade," *Indian Economic Journal*, 10 (October, 1962).
- Bharadwaj, R. *Structural Basis of India's Foreign Trade—A study suggested by the input-output analysis* (forthcoming).
- Caves, R. E. *Trade and Economic Structure: Models and Methods*, Harvard University Press, 1960.
- Caves, R. E. and R. W. Jones, *World Trade and Payments*, Little Brown and Company, 1973.
- Clement, M. O., R. L. Pfister and K. J. Rothwell, *Theoretical Issues in International Economics*, Houghton Mifflin Company, 1967.
- Diab, M. A. *The United States Capital Position and the Structure of its Foreign Trade* (1956).
- Freeman III, A. M. *International Trade: An Introduction to Method and Theory*, Harper and Row, Publishers, 1971.
- Gomes, L. *International Economic Problems*, St. Martin's Press, 1978.
- Kennen, P. B. *International Trade and Finance: Frontiers for Research*, Cambridge University Press, 1975.
- Leontiev, W. W. "Domestic Production and Foreign Trade: The American Capital Position Re-Examined," *Economia Internazionale VII* (1954).
- Leontiev, W. W. "Factor Proportions and the Structure of American Trade: Further Theoretical and Empirical Analysis," *Review of Economics and Statistics*, 38 (November 1956).
- Linder, S. B. *An Essay on Trade and Transportation*, John Wiley and Sons, 1961.
- Lindert, P. H. and C. P. Kindlebinger, *International Economics*, Richard D. Irwin, Inc., 1982.
- Minhas, B. S. *An International Comparison of Factor Costs and Factor Use*, Amsterdam, North Holland Publishing Company, 1963.
- Naya, S. "Natural Resources, Factor Mix and Factor Reversals in International Trade," *American Economic Review*, 57 (May 1967).
- Richardson, J. D. *Understanding International Economics; Theory and Practice*, Little Brown and Company, 1980.
- Robinson, R. "Factor Proportions and Comparative Advantage," *Quarterly Journal of Economics* (Part I: May 1956, Part II: August 1956).
- Sodersten, B. *International Economics*, Harper and Row, Publishers, 1970.
- Tatemoto, M. and S. Ichimura, "Factor Proportions and Foreign Trade: The Case of Japan," *Review of Economics and Statistics*, 41 (November 1959).
- Travis, W. P. *The Theory of Trade and Projection* (1964).
- Wahl, D. F. "Capital and Labor Requirements for Canada's Foreign Trade," *Canadian Journal of Economics and Political Science*, 27 (August 1961).

## ERRATA

- Gempesaw, Conrado M. II, and James W. Dunn. "Technological Structure and Technical Change in the U.S. Northeast Farm Region." 15(1986):137-144.

Equation (9) on page 142 should be

$$(9) \quad B_{jk} = \left( \frac{\partial^2 \pi^*}{\partial R^*_{j\partial t}} \cdot \frac{1}{x^*_{j\partial}} \right) \cdot t - \left( \frac{\partial^2 \pi}{\partial R^*_{k\partial t}} \cdot \frac{1}{x^*_{k\partial}} \right) \cdot t.$$

The correct equation was used in the calculations but transcribed incorrectly for the article.