The leontief paradox and why it is a paradox

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For purposes of analysis, we begin by introducing the Heckscher-Ohlin Theorem that argues that “ a country exports those commodities produced with relatively large quantities of the country’s relatively abundant factor”. Hence a country that has more capital per worker should export capital-intensive products and import goods that would require an exhaustive use of its scant resources (Minabe 1966, p. 1193).

Leontief (1953) tested empirically this theory of international trade by using an input-output analysis. Astonishingly, his results revealed that the United States, in spite of being the most capital-rich post-world war II country, was actually exporting labor-intensive commodities and importing capital-intensive commodities.

For a better understanding, check table 1 in the appendix about Leontief’s empirical findings. If we compute (2)/(1) it seems that US import replacements were 30% more capital-intensive than exports. This data-based method reinforced Leontief’s thesis that “ America’s participation in the international division of labor is based on its specialization on labor intensive, rather than capital intensive, lines of production” (Leontief 1953, p. 17). Such perplexing results have become known as the “ Leontief Paradox” due to the fact that they were surprisingly inconsistent with the so far undisputed Heckscher-Ohlin theory.

Several interpretations were given to this conundrum. Leontief himself tried to puzzle out his own paradox by arguing that American labor is three times more productive than world labor as a result of a fervid entrepreneurship, an

outstanding economic framework and a favorable environment with plenty of incentives (Leontief, 1953).

Some economists pointed out that Leontief disregarded worker's skill and this could be seen as a major explanation if we regard that human capital is the US's relatively abundant factor. A study by Branson and Monoyios (1977) revealed that industries that extensively integrate human capital in their strategy are more likely to appear on the export side. Empirical evidence suggests that the US was a skill-abundant country. Consequently, the paradox may be erased if we estimate the amounts of human capital employed in exported goods and reformulate Leontief calculus of physical capital by considering this new data (Kenen 2000).

Additionally, Leontief recognized that considering only labor and capital as inputs of a nation is unrealistic and therefore he highlighted a country's endowment of natural resources as a crucial element in production. Vanek (1959) proved that there is a high degree of complementarity between natural resources and capital which is consistent with the fact that US imports are more natural resource intensive than exports (Vaghefi et al 1991). This conclusion also reinforced Stern's (1981) article that stated if we add a third factor of production to the model, specifically natural resources, there is no paradox since most of the goods Leontief considered to be labor-intensive were indeed natural resource intensive (Clarke and Kulkarni 2009, p. 117).

Valvanis-Vail (1954) suggested that if " per capita incomes differed, different demand patterns could arise at the same price ratios". Thus a capital-

abundant country would have a bias in flavor of capital-intensive goods that could prevail over its factor abundance. Although, Brown (1967) and Travis (1964) contradicted this by showing a demand bias in flavor of labor-intensive goods (Perdikis and Kerr 1998).

Another explanation is the so-called factor-intensity reversals. “ A factor-intensity reversal occurs when the relative prices of labor and capital change over time or place causing the relative mix of capital and labor in the production process of a commodity to change from being capital intensive to labor intensive, or vice versa” (Vaghefi et al 1991, p. 66). Minhas (1962) found some evidences of factor intensity reversals at some point but this argument vanished when several other economists such as Leontief (1964) himself and Ball (1966) showed that this phenomenon is atypical and occurs mostly in industries that are relying heavily on natural resources.

Baldwin (1972) also found evidences that trade barriers might explain a significant portion of the Leontief Paradox. In summary, it can be argued that most of the US imports were capital intensive because tariffs and other trade policies restricted labor-intensive imports in order to perceive American jobs.

Besides, US is well-known for producing inventive and sophisticated goods that require many time until they are fully developed and prepared for mass production. Since these experimental procedures demand a high-skilled workforce this means that the trade structure of the US is camouflaging a substantial dexterous and ingenious work that is more likely to be considered as “ technology-intensive” or “ R&D intensive” rather than labor-intensive. (Krugman 2003).

Leamer (1980) proved that we cannot deduce which factor will prevail in imports or exports for a trade that is not in balance (Winters 1992) and he suggested that we should make a comparison between net exports and domestic expenditure. This argument claimed to dismantle the paradox if " the capital per worker is greater in net exports than in consumption" (Brecher and Choudhri 1982, pp. 820-823). On examining the data from table 2 (check appendix), we can easily notice that net exports are much more capital intensive than consumption. Thus, according to Leamer, US seems to be relatively well endowed in capital compared with labor hence Leontief's original data do not show any paradox.

We conclude by answering the following question: " Is it still a paradox?". In my humble opinion most of the arguments presented above show signs that there is no paradox after all. In fact, differences in human capital that affect productivity and technology along with Stern's and Leamer's theses seem to explain Leontief's discovery.

Should economist discard the Heckscher-Ohlin theorem as a practical explanation of trade patterns and search for other theories of trade?

We start by synthetizing some important Heckscher-Ohlin hypothesis: two-country, two-commodity and two-factor. Hence factor prices equalize across countries if we assume non-existence of trade barriers and transportation costs; competitive forces that assure industry equilibrium; absence of factor intensity reversal; production functions that exhibit constant returns to scale; no complete specialization; and identical technology between countries.

Before all else, why does the model fails? As we seen before, Leontief Paradox undermined the principles of Heckscher-Ohlin Model by showing a contradiction between data and theory. Apart from that, the model is depending on vulnerable and unrealistic assumptions. In reality, even if technology advances allowed a declining in costs, it seems erroneous to assume that they are zero. It is also unsatisfactory to consider that world trade is completely free since lobby persists and some “ trade frictions” remain. Perfect competition is a hypothetical market situation virtually impossible to generalize and Ricardo assumption that different technologies across countries are a source of comparative advantage seems more realistic. Finally, it looks very restrictive to compute world trade using only two countries and two goods.

Bowen, Leamer and Sveikauskus (1987) tested the H-O proposition that trade reveals factor abundance and they found a not so strong association between factors embodied in trade and factor supplies (Bowen et al 1987, pp. 791-809). “ This result confirms the Leontief paradox on a broader level: Trade often does not run in the direction that the Heckscher-Ohlin theory predicts” (Krugman 2003).

Trefler (1995) also discovered a “ case of missing trade”. Basically, if trading goods is an indirect way of trading factors of production then it is possible to estimate the volume of that trade. Evidence shows us that there is a big differential between measured factor trade and Heckscher-Ohlin model predictions.

The Heckscher-Ohlin model can as well be accused of predicting poorly the link between trade and wages. Samuelson (1948) showed that owners of abundant factors will gain from trade and owners of scarce factors will lose during the process of factor price equalization. In practice, openness will reduce wages and increase unemployment of low-skilled workers in advanced countries. Conversely, we forecast a raise in low-skill workers' wages relative to the wages of skilled workers in developing countries, so the gap between them will eventually evanesce (Peteers and Vaal 2000, p. 1). However, we found some cases where the reverse has occurred (i. e. China and Mexico) suggesting that the model's predictions are not that accurate.

How does the model stands up against this " theoretical assault"? Bowen stated about the basic set-up of the model that " Heckscher-Ohlin [model] does poorly, but we do not have anything that does better" (Bowen et al, 1987 pp. 805). Trefler's also confessed that his " missing trade" revelation was due to international technology differences and a home bias in consumption. Thereafter, a valid suggestion was given to reconsider some of the model's assumptions and in particular to combine "[Armington] home bias with neutral international technology differences" (Trefler, 1995).

Income inequality between skilled and unskilled workers may be attributed to skill-biased technological change rather than an increase on trade. Berman et al (1997) showed that this is a plausible explanation for the escalation on wage premiums for skilled workers and the upswing proportion of skilled workers employed within an industry.

Lastly, another argument supporting H-O Theorem was given by Wood. He alleged that capital must be excluded from the model and instead he compared the skill of manufactures traded between pairs of developed and developing countries (Clarke and Kulkarni 2009, p. 119). The study showed that sophisticated goods are usually exported by developed countries, thus “ theory often seems to perform rather well” (Wood 1997). Other notables developed prominent researches that corroborate H-O theory, such as David Clifton (1984), Brecher (1993) and Schott (2003).

To give a summing-up, I believe the H-O model needs a reformulation in order to be more accurate in predicting patterns of trade. As the world keeps moving in the free trade direction, the absence of trade barriers is turning into a valid assumption. However, the other conventional assumptions of the model appear to be very restrictive and they need to be reinvented again, particularly that technology is not identical everywhere.

Anyway we cannot deny the importance of the Heckscher-Ohlin model since plenty of recent research endorses most of its outcomes, especially the effects of trade in income distribution.