Critical Evidence on Comparative Advantage? North-North Trade in a Multilateral World

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There are two principal theories of why countries trade: comparative advantage and increasing returns to scale. Which is most important in practice? The large volume of intra-OECD trade is frequently cited as critical evidence on this question. It is argued that comparative advantage, unlike scale economies, is incapable of accounting for the large volume of trade between seemingly similar economies. This is a theoretical claim. In this paper, I show that it is possible to give an account of this trade based on comparative advantage. The elements that may give rise to a large volume of North-North trade are traced to identifiable features of technology and endowments.

International trade theory's first and most fundamental problem is to explain why countries trade. Two principal theories have emerged: comparative advantage and increasing returns to scale. From the time of David Ricardo until the early 1980s, professional opinion accorded comparative advantage pride of place. In the last 15 years, increasing returns has closed, and perhaps reversed, the relative positions. An important element motivating the shift in favor of increasing returns has been the observation that a great deal of world trade occurs between the major OECD countries (the "North"). This has been viewed as puzzling within a comparative advantage framework, which relies on cross-country differences (in

endowments, technology, etc.) to explain trade. As a result, the large volume of North-North trade has been taken as critical evidence favoring a scale economies theory over one based on comparative advantage.[1]

There are reasons to question this account. In its simplest form, it is claimed that the endowments of these countries are too similar to admit a large volume of trade. Yet Leamer (1984) has emphasized that the Heckscher-Ohlin-Vanek model specifies a tight link between endowments, technology, and trade. As a result, it would be extremely surprising if we could say something strong about bilateral trade volumes based solely on endowments, disregarding the underlying technologies. When technologies are mentioned in this context, it is usually to assert that the fact that much of this North-North trade involves goods of similar factor intensity compounds the paradox.

This paper will develop a highly structured model of trade in a strictly conventional Heckscher-Ohlin-Vanek (HOV) framework. It will make explicit the links between endowments, technology, and trade volumes, and it will show that the HOV framework places no restriction that the volume of North-North trade should be small relative to North-South trade. This paper shows that the technologies employed are crucial to understanding the problem of trade volumes. In fact, the observation that much of this trade involves goods of similar factor intensity is not a puzzle, but instead facilitates a large volume of North-North trade. As a result, the observation that a great deal of world trade is North-North, much of it in goods of similar factor intensity, can provide no evidence to prefer an account of trade based on increasing returns rather than comparative advantage.

Endowment Differences and Bilateral Trade Volumes: The Role of Technology

I consider a world with a great deal of symmetry. Preferences of all individuals are identical and homothetic. All goods enter utility symmetrically, so that at a relative price of unity, spending is equal across all goods. I assume that distinct sectors employ factors in different proportions. Yet I assume that there is symmetry in technologies across the goods, so that at a common price for all factors (each in the appropriate units), and with spending equal across all goods,

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[1] See Deardorff (1984, p. 500), Helpman and Krugman (1985, p. 2), Grossman (1992, p. 1), and Smith (1994, p. 43). For cautions on this view and insights into intraindustry trade in a comparative advantage setting, see Markusen (1986), Markusen and Wigle (1990), Chipman (1992), and Davis (1994, 1995).

the aggregate derived demand for all factors is the same. I shall in fact assume that (in the appropriate units) the world supply is the same for all factors. All trading equilibria that are considered will be restricted to satisfy the conditions of Dixit and Norman (1980) for the world with trade to replicate the equilibrium of the integrated world. Finally, I consider only a set of comparative statics that preserve these symmetry conditions. As a result, in all that follows, the price of all goods will equal unity, and the prices of all factors will be common. Let us now examine a minimalist framework that satisfies the conditions above and is adequate to the questions addressed. This is one with four countries, goods, and factors.[2]

Let the world endowment of factors be given by $V^W = [V_1^W \ V_2^W \ V_3^W \ V_4^W]'$. I shall refer to the first two factors as North-type factors, since they will be the factors that are abundant in the North (in a sense to be discussed shortly). Similarly, the latter two factors will be considered South-type factors. For the reasons of symmetry discussed above, all factors exist in the world of interest in equal quantities (in appropriate units).

As long as the distribution of endowments across the countries satisfies the Dixit and Norman (1980) requirements of the integrated equilibrium, factor prices will be equalized. Thus the techniques implemented in each country will be equal to those employed in the fully integrated world and can be summarized by a technology matrix, A. This matrix must satisfy the symmetry conditions outlined above. I want to be able to parameterize the degree of interindustry input differentials and would also like to parameterize the degree of technical differences of goods within industries.

The structure of technology will play a crucial role in determining bilateral trade volumes. The technology can be represented by the 4 × 4 matrix of input coefficients, A. Let the first two columns of A reflect input coefficients for the goods in the North-type industry and the latter two columns those for goods in the South-type industry. Analytically, it will prove convenient to express these input coefficients as the sum of three components:

$$A = B + \delta D + \epsilon E. \tag{1}$$

[2] Greater generality is possible but would serve to obscure rather than enlighten. Raising the number of countries relative to the number of goods and factors could introduce some indeterminacies into trade patterns. Yet these indeterminacies could arise even with the 4 × 4 × 4 framework. And since they may even raise the opportunities for North-North trade, I rule them out as making the task too simple. For similar reasons, I do not consider a world with more goods than factors. It is well known that raising the number of factors above the number of goods makes factor price equalization, a central element of HOV theory, a knife-edge. So I similarly exclude this consideration. For these reasons the 4 × 4 × 4 framework is appropriate to the problem.

The matrix $\mathbf{B} = [b]$ is a constant matrix with $b > 0$ and reflects the average input coefficients across the four goods. The remaining two components, $\delta \mathbf{D}$ and $\epsilon \mathbf{E}$, therefore represent deviations from this base and so distinguish the goods technologically. For definiteness, assume δ, $\epsilon > 0$.[5] The matrix $\mathbf{D}$ will have the characteristic that the columns $\mathbf{D}_1 = \mathbf{D}_2 = -\mathbf{D}_3 = -\mathbf{D}_4$. Since the first two columns represent the goods in the North-type industry and the latter two the goods in the South-type industry, this implies that a parametric rise in δ increases the technological dispersion *between* industries. In the example developed here, this increases the reliance of the North-type goods on North-type factors, while reducing the reliance on South-type factors (and vice versa for South-type goods). The matrix $\mathbf{E}$ is symmetric, and its columns have the feature that $\mathbf{E}_1 = -\mathbf{E}_2$ and $\mathbf{E}_3 = -\mathbf{E}_4$. From this it is clear that a parametric rise in ϵ increases the technological dispersion *within* industries. Thus a suitable technology matrix can be represented:

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\mathbf{A} = [b] + \delta \begin{bmatrix} 1 & 1 & -1 & -1 \\ 1 & 1 & -1 & -1 \\ -1 & -1 & 1 & 1 \\ -1 & -1 & 1 & 1 \end{bmatrix} + \epsilon \begin{bmatrix} e_1 & -e_1 & e_2 & -e_2 \\ -e_1 & e_1 & -e_2 & e_2 \\ e_2 & -e_2 & e_1 & -e_1 \\ -e_2 & e_2 & -e_1 & e_1 \end{bmatrix}. \quad (2)
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I now address the senses in which the first two industries can be grouped as North-type goods relative to the latter two as South-type goods.[4] This will be expressed as a restriction on the relative strength of interindustry versus intraindustry input differences, that is, in terms of δ and ϵ. Recall that the first two factors are provisionally assumed to be more abundant in the North and the last two more abundant in the South. Recall also that as a result of the symmetry assumptions, the prices of all factors are the same, and similarly for all goods. For this reason, a statement about absolute levels of costs across goods is also a statement about relative costs. Thus one can describe two senses in which the first two goods may be taken as North-type goods. A weak restriction is that for each of these goods and for each of these factors, a greater share of the cost of that good comes from each of the North-type factors than from either of the

[5] This, along with $e_1 \neq e_2$, ensures that the factor price equalization set has full dimension (see Helpman and Krugman 1985).

[4] There is an important definitional issue. Discussions of the endowments theory of trade emphasize grouping goods into industries according to similar input composition. This is in fact the reason that intraindustry trade has been looked on as a puzzle in this setting (Helpman and Krugman 1985). Yet once one moves beyond two factors, the concept of factor proportions has no obvious analytic counterpart. The restrictions outlined in the paper represent alternative approaches to operationalizing the concept of similarity in factor proportions in a multifactor world. See also Chipman (1992) and Davis (1994).

South-type factors. This can be shown to require the restriction that $\delta > (\epsilon/2)(e_1 + e_2)$. By symmetry, the same restriction would also hold for the South-type goods. A stronger restriction would require in addition that for each of the North-type goods the share of cost accounted for by each of the North-type factors be more similar than either is to the share of cost accounted for by either of the South-type factors (and vice versa for South-type goods). A sufficient condition for this is $\delta > (\epsilon/2) \max[3e_1 + e_2, e_1 + 3e_2]$. Both conditions stress the sensible restriction that to group these goods into industries, input differences should be large *between*, rather than *within*, industries: δ should be large relative to ϵ.

Having established the characteristics of our technology, let us now turn to establishing how this technology links cross-country endowments and trade patterns. The starting point is the classic Heckscher-Ohlin-Vanek equation (see Helpman and Krugman 1985). Let $\mathbf{A}$ be our technology matrix as above, let $\mathbf{T}^C$ be the net export vector for country C, let $\mathbf{V}^C$ be the vector of endowments for country C, let s^C be its share of world income, and, as above, let $\mathbf{V}^W$ be the world endowment vector. Then the HOV equation can be expressed variously as

$$\mathbf{A}\mathbf{T}^C = \mathbf{V}^C - s^C\mathbf{V}^W \tag{3}$$

or

$$\mathbf{V}^C = s^C\mathbf{V}^W + \mathbf{A}\mathbf{T}^C. \tag{3'}$$

Equation (3) is the conventional way of expressing HOV. It holds that the net factor content of trade ($\mathbf{A}\mathbf{T}^C$) for country C is equal to the endowment ($\mathbf{V}^C$) less its share of the world implicit absorption of factor services ($s^C\mathbf{V}^W$). The second version, embodied in equation (3'), will figure most importantly in our work. It takes a country whose share of world income is s^C and shows what its endowments need to be ($\mathbf{V}^C$) in order for it to have the net trade vector $\mathbf{T}^C$ with the rest of the world. In effect, it allows one to design an HOV world that in equilibrium will yield the bilateral trade vector of interest. Of course, not all trade patterns are possible. They must remain consistent with the requirements of the integrated equilibrium. And for an arbitrarily selected trade pattern, there is no guarantee that the resulting world endowment patterns will neatly divide into the North-South division of interest in our work.[5]

The difference in endowments between any pair of countries will reflect the bilateral trade of each of these countries with all coun-

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[5] I examine this more closely below. In essence, I require for division into North and South that each North country be a net exporter of the services of both North-type factors (1 and 2) and a net importer of the services of both South-type factors (3 and 4) (and vice versa for a country of the South).

tries. However, for analytic purposes, it proves convenient to abstract from this for now to consider endowment differences specifically linked to each type of trade. Let us begin by examining the differences between North and South and then consider the North-North case. Assume that world income is evenly divided between North and South.[6] Let $\mathbf{T}^{NS}$ be the net export vector of the North with respect to the South. Then the endowments of the North (with the two countries taken together) and the South, respectively, are

$$\mathbf{V}^N = \frac{\mathbf{V}^W}{2} + \mathbf{A}\mathbf{T}^{NS},$$

$$\mathbf{V}^S = \frac{\mathbf{V}^W}{2} - \mathbf{A}\mathbf{T}^{NS}. \tag{4}$$

It will prove very convenient to have a scalar proportional to the volume of North-South trade. No insight is lost in constraining the volume of North exports and imports to be the same across the goods within an industry. Accordingly, restrict $\mathbf{T}^{NS} = (t^{NS}/4)\,[1\ 1\ -1\ -1]' \equiv (t^{NS}/4)\,\mathbf{D}_1$. Here t^{NS} is the total trade volume (exports plus imports) of the North with all of the South. This allows us to develop a simple expression for the aggregate endowment differences between the North and South, which are denoted $\mathbf{\Delta}^{NS} = \mathbf{V}^N - \mathbf{V}^S = 2\mathbf{A}\mathbf{T}^{NS}$. Simple calculations then show that these endowment differences can be written as

$$\mathbf{\Delta}^{NS} = 2t^{NS}\delta\mathbf{D}_1. \tag{5}$$

Parallel calculations can be made for endowment differences between North countries specifically linked to North-North trade. Assume that the North countries do not export any of the South-type goods and that their bilateral trade is balanced. Assume without loss of generality that North country 1 is the exporter of good 1 in exchange for imports of good 2 from North country 2. Then the net bilateral trade vector for, say, North country 1 is $\mathbf{T}^{NN} = t^{NN}[\frac{1}{2}\ -\frac{1}{2}\ 0\ 0]'$. Here t^{NN} is the total trade volume that is North-North. As above, this allows us to derive the endowment differences specifically linked to bilateral trade between the North countries. These differences are expressed as $\mathbf{\Delta}^{NN} = 2\mathbf{A}\mathbf{T}^{NN}$. Simple calculations show that this can also be written as

$$\mathbf{\Delta}^{NN} = 2t^{NN}\epsilon\mathbf{E}_1. \tag{6}$$

Equations (5) and (6) provide exactly the kind of link between endowments, technology, and trade of which Leamer (1984) wrote.

[6] The natural alternative, that the North is larger than the South, would tend to relax constraints on the problem, allowing for the possibility of yet greater North-North trade.

The first observation is that for fixed technologies (δD_1 and ϵE_1), a rise in the volume of trade (t^{NN} or t^{NS}) must be associated with larger endowment differences, Δ^{NN} and Δ^{NS}, respectively. This is the core of truth behind the frequent assertion that the greater the differences between countries, the larger the volume of trade.

However, there is another equally important way of looking at equations (5) and (6): For fixed endowment differences, the volume of trade depends crucially on the structure of technology, indexed by δ and ϵ. Recall that δ parameterizes the strength of interindustry input differences. Thus, if the goods in which North and South specialize are very different in their input intensities (large δ), even a small trade volume (t^{NS}) suffices to accomplish the required net factor content of trade. An alternative way of looking at this is to recall that trade volume is a measure of the *gross* factor content of trade, weighted by the competitive rentals, whereas HOV places restrictions only on the *net* factor content of trade (see Helpman and Krugman 1985). When goods differ greatly in their factor contents, there is little cross-hauling of factor services. Hence net factor contents can be large even as North-South trade volumes are small.

Recall also that ϵ parameterizes the degree of input differences for goods within an industry. If ϵ is relatively small, then the intraindustry trade within the North involves goods of similar factor intensity. This implies that this North-North trade involves a great deal of cross-hauling of factor services. Thus even though the net factor content of trade may be small, it is possible that the gross factor content, hence the volume of North-North trade, may be large. This relation may be observed directly in equation (6) by the fact that for fixed endowment differences Δ^{NN}, a smaller ϵ must be associated with a larger t^{NN}, an index of the volume of trade.

North-North Trade: No Puzzle for Comparative Advantage

To this point we have been exploring the structural links between endowments, technology, and trade volumes. But we need to go further. We know that actual trade patterns feature a large volume of North-North trade, a smaller volume of North-South trade, and yet smaller volumes of South-South trade. The major result of this paper is that such trade patterns *are* consistent with a strictly conventional HOV world.

As before, let the scalar t^{NN} be the total volume of North-North trade, t^{NS} be the total volume of North-South trade, and t^{SS} be the total volume of South-South trade. Then the major result can be stated.

THEOREM. In a strictly conventional Heckscher-Ohlin-Vanek world satisfying the Dixit-Norman conditions for trade to replicate the integrated equilibrium, there exists a partition of world endowments among countries and a set of common technologies such that $t^{NN} > t^{NS} > t^{SS}$.

Proof. Since the proposition concerns existence, a numerical example would suffice. However, it is possible to provide a more constructive example that draws on the analytics we have developed. This proceeds in two parts. The first is to determine the pattern of trade of interest and to derive the division of world endowments that will yield this trade pattern in equilibrium. The second is to verify that two types of consistency requirements are satisfied: (1) The endowments must satisfy conditions defining countries as North and South, whereas the technologies must satisfy conditions defining goods as relying on North-type and South-type factors. (2) Outputs, endowments, and input coefficients all must be nonnegative.

In the example we develop, we shall set $t^{NN} = 1 + \mu > 1$. This will consist of an equal value of good 1 exported from North country 1 in exchange for imports from North country 2 of good 2. We shall set $t^{NS} = 1$. This will consist of one-fourth unit of good 1 from North country 1 in exchange for one-fourth unit of good 3 from South country 3, and a similar balanced exchange between North country 2 and South country 4 in goods 2 and 4, respectively. We shall set $t^{SS} = 0$. Thus, in this example, $t^{NN} = 1 + \mu > t^{NS} = 1 > t^{SS} = 0$, as required for the theorem.

From equation (3′), and for the technology matrix **A** from equation (2), these will be the equilibrium trade patterns and volumes if the endowments of the countries are as follows:

$$V^1 = \frac{\mathbf{V}^W}{4} + \frac{1 + \mu}{2}(A_1 - A_2) + \frac{1}{4}(A_1 - A_3),$$

$$V^2 = \frac{\mathbf{V}^W}{4} + \frac{1 + \mu}{2}(A_2 - A_1) + \frac{1}{4}(A_2 - A_4),$$

$$V^3 = \frac{\mathbf{V}^W}{4} + \frac{1}{4}(A_3 - A_1),$$

$$V^4 = \frac{\mathbf{V}^W}{4} + \frac{1}{4}(A_4 - A_2).$$

For each of the countries, the first term represents an endowment of factors proportional to world endowments, and the remaining terms represent the net factors that in equilibrium will give rise to the pattern and volume of trade identified above.

In order for this equilibrium to be feasible, several consistency conditions must be met. For each country and for each good, out-

puts must be nonnegative. Similarly, for each country and for each factor, endowments must be nonnegative. Both of these conditions can be satisfied simply by making V^W as large as required, since this raises outputs and endowments without affecting the trade pattern. In addition, for each good and factor, input coefficients must be nonnegative. This can be ensured simply by making the average input coefficient b from equation (2) as large as necessary.

There are two more conditions. The first is that the first two goods (the exports of the North countries) must use the first two factors relatively intensively. I discussed two versions of this earlier, one requiring that $\delta > (\epsilon/2)(e_1 + e_2)$ and the other that $\delta > (\epsilon/2) \times \max[3e_1 + e_2, e_1 + 3e_2]$. The final condition is simply to confirm that these endowments, conditional on these technologies, in fact do make the countries designated as North countries net exporters of the services of both North-type factors 1 and 2 and net importers of the South-type factors 3 and 4, and vice versa for countries of the South. This likewise places a restriction that δ be large relative to ϵ.[7] With freedom to choose δ and ϵ as we wish, we need merely choose them to satisfy the most stringent of these constraints. Thus the proof is complete.

A few words of interpretation are in order. We have proved that such trade patterns are consistent with a conventional HOV world. But it is a further step to suggest that this is indeed a plausible account for these trade patterns. In considering this question, the reader should keep in mind that the existence proof has forgone consideration of a variety of factors, all of which may serve to enhance the volume of North-North trade (see, e.g., Markusen 1986; Markusen and Wigle 1990). The first is that protection levels in the North tend to be lower than in the South. Second, if we allowed for nonhomotheticities in consumption, the higher per capita incomes in the North might serve to correlate consumption patterns, generating greater North-North trade. Third, we have abstracted from the fact that the North in aggregate is larger than the South, which may further enhance the opportunities for North-North trade relative to North-South trade. In sum, whether comparative advantage or

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[7] Formally, the restriction for the two North countries may be written as

$$\delta > \frac{\epsilon}{2} \max \left[|(5 + 4\mu) e_1 - e_2|, |(5 + 4\mu) e_2 - e_1| \right].$$

The restriction for the two South countries may be written as

$$\delta > \frac{\epsilon}{2} |e_2 - e_1|.$$

Both require simply that δ be sufficiently large relative to ϵ, as in the earlier restriction on the technologies.

increasing returns will provide a more compelling account of the pattern and volume of trade cannot be judged on an a priori basis.

Conclusion

It is frequently argued that the large volume of North-North trade is puzzling when viewed within the framework of comparative advantage, and specifically within a model in which trade is driven by endowment differences. This is offered as a reason to prefer models of trade that rely on increasing returns rather than those premised on comparative advantage. This paper has shown that such assertions are not well founded. They ignore the crucial link between endowments and trade volumes provided by technology. Once this is accounted for, it is possible to have a strictly conventional Heckscher-Ohlin-Vanek model in which the volume of North-North trade exceeds that of North-South trade. Accordingly, the volume of North-North trade cannot be used as evidence to prefer theories based on increasing returns rather than comparative advantage.

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