

Do Factor Endowments Matter for North-North Trade?

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Abstract

The central paradigm of world trade patterns divides this into two elements. Trade between North and South is viewed as determined by traditional comparative advantage, largely determined by differences in endowment patterns. Trade within the North is viewed as determined by specialization due to economies of scale and product differentiation. In this paper, we will argue that this division is seriously misleading about the nature of North-North trade. We will say that endowments matter for North-North trade if two conditions are met: (1) Patterns of net factor trade are systematically related to endowment differences; and (2) The magnitudes are economically large. Our empirical work confirms that both of these conditions are met. Using actual technology matrices, we show that true net factor service trade of wealthy countries is typically not zero but 10-12 percent of national endowments, and between 38 and 49 percent of their endowments devoted to tradables. Moreover, while an assumption of FPE forced empirical researchers to assume intra-industry trade carries no net factor content, we demonstrate that for half of the countries in our sample intra-industry trade is actually a more important conduit for net factor service trade than inter-industry trade. Finally, we show that contrary to the conventional wisdom, endowments are an important determinant of bilateral trade even among wealthy countries. Taken together, these results undermine the notion that North-North trade is largely devoid of factor content and that the prevalence of intra-industry trade is a puzzle for models of comparative advantage.

Do Factor Endowments Matter for North-North Trade?

The new trade theory of the 1980's is primarily recognized for its novel contributions regarding increasing returns, product differentiation and imperfect competition.¹ Yet the influence of this literature goes beyond simply adding one more model to the canon. In a pair of influential papers, Krugman (1981) and Helpman (1981) articulated a vision of world trade patterns that integrated the new trade theory with the traditional factor endowments theory of Heckscher-Ohlin. In this formulation, each theory plays a role, but the roles differ. Trade among rich countries of the North is intra-industry and takes advantage of gains from specialization in a world of scale economies. Trade between North and South is inter-industry based on differences in factor endowment. This hybrid paradigm is now the profession's dominant vision of the determinants of world trade patterns.

In arguing for the empirical relevance of the scale economies element of this paradigm, Krugman (1981) cited two seeming-paradoxes in world trade patterns when viewed through a factor endowments lens: "First, much of world trade is between countries with similar factor endowments. Second, a large part of trade is intra-industry in character – that is, it consists of two-way trade in similar products."² In effect, this paradigm specifically denied that factor endowment differences are important for understanding trade *among* the rich countries of the North, for which instead it turns to the new trade theory. And the predominance of intra-industry

¹ See the seminal papers of Krugman (1979) and Lancaster (1980).

² These observations about trade patterns were offered specifically to motivate a move to the new trade theory view which could account for these facts even among countries with identical endowments. Krugman (1980) also appealed to one element apart from trade patterns: an apparent absence of substantial distributional impact of trade reform.

trade is also viewed as a puzzle, because this is viewed as trade in goods of similar factor intensity.

This paper provides the first sound empirical scrutiny of the role of factor endowments in determining North-North trade. It has not been possible to examine this empirical issue previously because the literature on trade in factor services was dominated by anomalies and conundrums, such as Trefler's (1995) "mystery of the missing trade," rather than models that matched well with the data.³ Recently, Davis and Weinstein (1998) have provided a simple theoretical framework that provides a surprisingly strong match between prediction and data for trade in factor services. This is the starting point for the present paper.

We will say that endowment differences are important for North-North trade if two criteria are met: (1) Factor service trade among countries of the North is *systematically* related to endowment differences; and (2) The magnitudes of factor service trade are economically large. Our results show that both criteria are met.

This implies that our core vision of the determinants of world trade patterns needs to be amended, particularly as it pertains to trade among the rich countries of the North. As the current paradigm suggests, scale economies and product differentiation may well be important for trade within the North – nothing that we do contests this. What we show is that endowments matter not only for North-South trade, but for trade within the North as well. Factor service trade for countries of the North is systematic, economically large, and frequently more intensively directed toward other countries of the North than toward the South.

³ Cf. Bowen, Leamer, and Sveikauskas (1987), Trefler (1995), and Gabaix (1997).

Moreover, our work forces a reconsideration of the role of intra-industry trade. Conventionally its importance for bilateral trade among countries of the North is taken as evidence that endowments do not matter for this trade. What we show instead is that, when properly conceived and measured, intra-industry trade is instead one of the principal conduits of factor service trade for countries of the North.

We develop this paper in three additional sections. Section II articulates our basic theoretical framework, develops some new results regarding factor service trade with well-defined classes of countries, and provides a theoretical decomposition relating our measures to those employed in previous empirical work. Section III derives the principal empirical results. Section IV concludes.

II. Theory

The starting point for an investigation of the role of trade in factor services must be measurement. The classic framework for measuring trade in factor services is due to Vanek (1968). Trefler (1993, 1995) amends this in an adjusted factor price equalization framework to allow either for factor-augmenting or for Hicks-neutral technical differences. Deardorff (1982) and Helpman (1984) develop versions that are highly relevant for our work here, which allow for differences in relative factor prices across countries that cannot be handled as simple factor-augmenting differences. Davis and Weinstein (1998) develop a variant of the Deardorff-Helpman model with explicit consideration of the nature of technical differences, as well as the presence of non-traded goods, and show that such a model has substantial empirical support.

Here our concern is to move beyond a test of the theory to understand some key questions for which magnitudes matter. Is factor service trade important for countries of the North? If so, what is the relative importance in this trade of trade with other countries of the North? Is this factor service trade systematic, even among countries of the North? How does the fact that much trade within the North is intra-industry affect our view of factor service trade among these countries? Is intra-industry trade truly trade in goods of similar factor intensity? Over all, how important is intra-industry trade in the net exchange of factor services among countries of the North? To answer these questions, we specify a model that builds on Davis and Weinstein (1998).

The theoretical framework that we employ is exceedingly simple. We assume that we are in a Heckscher-Ohlin world with many goods, factors, and countries. Technologies are constant returns to scale. Preferences are identical and homothetic. Any technological differences are assumed to be of the factor-augmenting variety, so can be subsumed by converting factors to efficiency units. Factor price equalization is assumed not to hold for any pair of countries in our sample. The number of goods produced is assumed to be sufficiently large that we can safely ignore “boundary” goods produced by more than one country. In short, this is a standard multi-cone Heckscher-Ohlin model with specialization in traded goods. When considered in a two-factor framework, this model receives strong empirical support in Davis and Weinstein (1998).

In this paper, a prime concern will be tracking the factor content of trade. A standard way for measuring this in the case of No FPE is developed in Deardorff (1982) and Helpman (1984).⁴

⁴ This is very close to what Deardorff (1982) termed the “actual factor content of trade,” which allowed him his most general results. To make our measure and his coincide exactly would have required an iteration procedure that traces back factor contents of intermediates used in exports, the factor content of imported intermediates used in the production of those intermediates, etc. Because a great deal of the factor content comes from use of non-tradables and

The key insight is that when techniques of production vary across countries, as is the case when FPE fails, factor contents should be measured using the producer's technology. Allowing c and c' to index countries, B_{fc} to be the f th row of the total factor input matrix of country c , E_c to be gross exports from c , and $M_{cc'}$ to be gross imports by c from c' , the Deardorff-Helpman measure of the factor content of trade for country c in this case with No FPE is:

$$F_{fc} \equiv B_{fc} E_c - \sum_{c'} B_{fc'} M_{cc'}$$

Note that for the case with FPE, $B_{fc} = B_{fc'}$, so this reduces to the standard measure.

An extremely important question is how analytically correct Deardorff-Helpman measure of the net factor content of trade compares to the conventional measures of net factor trade that have been employed in the empirical literature. The conventional approach has been to assume that the appropriate measure of a country's net factor trade is the product of a common technology matrix, typically that of the United States, and the country's net trade vector. This is easily accomplished via a decomposition of the appropriate measure into two components, one reflecting the conventional measure, and the second reflecting various types of measurement errors inherent in the conventional measure.

To do the decomposition, it is useful to start with a few key concepts. First we define "matched intra-industry trade." In bilateral trade, it is the positive quantity of imports within an

because imports are typically a small portion of usage even in tradable sectors, we judged these issues to be of second order for our purposes. Note that Deardorff and Helpman used these measures to derive restrictions on comparative costs, whereas we will be concerned more directly with the measures of factor content themselves.

industry that can be exactly matched with the bilateral exports within the same industry. Using the mnemonic of Grubel-Lloyd, matched intra-industry trade is defined for industry i as:

$$G_{cc'}^i \equiv \min \{ E_{cc'}^i, M_{cc'}^i \}$$

Using this concept of matched intra-industry trade, it is possible to decompose the gross export vector into two components. Some goods we import on net, so that our gross exports equal precisely the level of matched intra-industry trade, $G_{cc'}^i$. Others we export on net, so our gross exports are the sum of matched intra-industry trade plus the net exports. If we define a variable $T_{cc'}^+$ to be the level of net exports where this is positive, and to be zero elsewhere, then our gross exports can be written as:

$$\begin{aligned} E_{cc'} &\equiv G_{cc'} + T_{cc'}^+ \\ &\equiv \text{Matched Intra - Industry Trade} + \text{Positive Net Exports} \end{aligned}$$

If we make a parallel definition for a variable $T_{cc'}^-$ to equal T_{cc} for goods that are net imports and zero otherwise, we can do a similar decomposition for our net imports:

$$\begin{aligned} M_{cc'} &\equiv G_{cc'} - T_{cc'}^- \\ &\equiv \text{Matched Intra - Industry Trade} - \text{(Negative) Net Imports} \end{aligned}$$

Just to tie this down, note that the net trade vector between c and c' is then:

$$T_{cc'} \equiv E_{cc'} - M_{cc'} \equiv (G_{cc'} + T_{cc'}^+) - (G_{cc'} - T_{cc'}^-) \equiv T_{cc'}^+ + T_{cc'}^-$$

Now we can turn to the decomposition of our appropriate measure of net factor trade. Since most previous studies employed the US technology matrix, we will use it for the decomposition. Recall that the conventional measure of country c 's factor content of trade has been:

$$F_{fc}^{Conv} \equiv B_{f US} T_c$$

If we add and subtract this from our appropriate measure from equation (1) above, we obtain the desired decomposition:

$$\begin{aligned} F_{fc} &\equiv F_{fc}^{Conv} - \left[\sum_{c'} (B_{f US} - B_{fc}) T_{cc'}^+ \right] - \left[\sum_{c'} (B_{f US} - B_{fc'}) T_{cc'}^- \right] + \left[\sum_{c'} (B_{fc} - B_{fc'}) G_{cc'} \right] \\ &\equiv F_{fc}^{Conv} + e_{NE} + e_{NI} + e_{MIT} \end{aligned}$$

The first term is the conventional measure of the factor content of trade employed in previous studies, based on all countries using US technology. The remaining three terms identify systematic errors associated with the conventional measure, and are straightforward to interpret. The first error arises when the factor content of country c 's net exports (NE) are incorrectly measured with the US technology matrix rather than the appropriate matrix from country c . The second source of error comes similarly from the fact that the factor content of net imports (NI) are incorrectly measured with the US technology matrix rather than that of the producer, country c' . The final error arises because the use of any common technology matrix defines matched intra-industry trade (MIT) to have zero factor content, whereas the true factor content of trade must take

account of the fact that even matched intra-industry trade will contribute to the net factor content, the level of which depends on the magnitude of matched intraindustry trade and the difference in techniques employed by c and c' .

So far we have been working with a country's trade with the rest of the world. The standard theory typically makes no prediction about bilateral factor contents because the bilateral pattern of goods trade may not be uniquely defined. Here, however, the assumptions of specialization and identical homothetic preferences allow us to make bilateral factor content predictions. Because of specialization, there is little harm in thinking of each country producing a single composite good using all of its factors, which it both consumes and exports. Thus the net factor content of trade in factor f between country c and c' , denoted $F_{fcc'}$, will be the difference between the exports of f from c and the imports of f by c :

$$F_{fcc'} = s_{c'}V_{fc} - s_cV_{fc'}$$

Simple manipulation of this implies that country c will be a net exporter of factor f bilaterally to any country such that:

$$\frac{V_{fc}}{s_c} > \frac{V_{fc'}}{s_{c'}}$$

In the reverse case it will be a bilateral net importer.

This last point is worth emphasizing. The typical country, one not at the extremes of abundance for a particular factor, will find that it is a net exporter of a factor to those less abundant than it as measured by V_{fc}/s_c and a net importer of those factor services in the reverse case. The measure of the net factor content of trade with the world as a whole tends to obscure

this systematic feature of the model because the positive and negative bilateral net factor trades may be canceling out. Moreover, it is important to stress that even if the total net factor trade is driven toward zero, this does not mean that the gains from being able to engage in these trades are likewise heading toward zero. Rather, there are gains from trading both with those more and less well endowed with the factor.

This motivates separating out for each factor and country the set of countries that are more or less well endowed with a factor. Let $\hat{U}(c, f)$ be defined as the set of countries c' more abundant in factor f than country c , i.e. in which $V_{fc} / s_c < V_{fc'} / s_{c'}$. Similarly, we can define $\hat{u}(c, f)$ as the set of countries for which c is more abundant in f , i.e. $V_{fc} / s_c < V_{fc'} / s_{c'}$. This allows us to calculate the factor content of trade separately for each country and factor with respect to those with which that country is a net exporter vs. importer of the factor services. Hence define:

$$F_{fc}^+ \equiv \sum_{c' \in \hat{U}(f, c)} B_{fc} E_{cc'} - \sum_{c' \in \hat{u}(f, c)} B_{fc'} M_{cc'} \quad \text{and}$$

$$F_{fc}^- \equiv \sum_{c' \in \hat{u}(f, c)} B_{fc} E_{cc'} - \sum_{c' \in \hat{U}(f, c)} B_{fc'} M_{cc'}$$

Finally, having spent so much time developing measures of the factor content of trade, we should say a few words about what we hope to learn from these measures. Deardorff and Staiger (1988) develop conditions under which it is possible to convert from factor content measures to welfare measures. The required restrictions are quite strong and do not hold in the present context. This makes it difficult to make strong normative statements based on the findings. Nonetheless, we do feel that the measures can be informative. First, the theory that we have developed actually places much stronger restrictions on the data than the traditional HOV theory,

including predictions bilaterally and to theoretically-identified subsets of countries. Hence it will be informative to see if the measures conform to these predictions. Second, the predictions and measures of net factor trade with the distinct groups of countries provide at least some coarse insight about the likely magnitude of impact on local factor markets of trade with the distinct groups of countries. Lastly, they will also provide again at least a coarse guide to how important trade in factor services is within the OECD as opposed to with the remainder of the world.

IV. Measuring Net Factor Trade

A. Data

All of our direct and indirect technology matrices for our OECD countries are constructed using information available in the STAN, ISDB, and OECD input-output databases. Each country's economy is divided into 34 sectors which yields industry definitions that are equivalent to ISIC three- or four-digit data. Endowment data are taken from these sources for our sample of ten OECD countries and from the Penn World Tables version 5.6. Trade data are taken from the OECD and from Feenstra, Lipsey, and Bowen (1997). The exact methods used to construct our technology matrices are often complex and details are described in detail in the data appendix to Davis and Weinstein (1998). An important difference between the data used in that paper and the data in this paper, is that all trade tests in the former work are conducted using estimated

technology matrices. In this paper, we only work with the actual technology matrices.⁵ All other data are identical in the two papers

All technology matrices and endowments were adjusted so that factor service flows are in efficiency units. This entails deflating each element of B_c and V_c by a Hicks-neutral parameter, \ddot{e}_c , corresponding to the productivity of factors in that country. \ddot{e}_{US} is arbitrarily set equal to unity. Each of these \ddot{e}_c 's is calculated according to specification P5 in Davis and Weinstein (1998). Since $B_c Y_c = V_c$, it must also be the case that we have full employment in efficiency units, i.e. $B_c^E Y_c^E \equiv (1/\ddot{e}_c) B_c Y_c = (1/\ddot{e}_c) V_c \equiv V_c^E$. To keep the notation simple, however, we have suppressed the efficiency unit superscript (E) in subsequent sections.

B. True and Conventional Measures of Net Factor Trade

In the theoretical section, we note that the starting point for our analysis is the Deardorff-Helpman measure of the factor content of trade in a No-FPE world. We also noted that this measure of the true factor content of trade can be decomposed into the conventional measure plus three sources of error. To place this in context, it is useful to think about what role might have been played by this measurement issue in the phenomenon that Trefler (1995) memorably termed the “mystery of the missing trade.” The mystery concerns a feature of the data under the conventional empirical implementation of HOV:

$$F_{fc}^{Conv} \equiv B_{fUS} T_c = V_{fc} - s_c V_{fW}$$

⁵The technology matrix for the rest of the world corresponds to the one used in specification T6 in Davis and Weinstein (1998). This matrix satisfies the full employment condition for the rest of the world.

In simple terms, the mystery in the data is that the measured net factor trade on the LHS is an order of magnitude smaller than the predicted factor trade based on endowments on the RHS.

The major thrust of Trefler's effort to solve this anomaly was to take the LHS as given and ask what amendments on the RHS would help. His preferred specification featured Hicks-neutral efficiency differences across countries and a home bias in demand. The assumption of a home bias directly scales down the RHS, but the efficiency difference will affect both sides of the equation.

Davis and Weinstein (1998) and Helpman (1998) argue that F_{fc}^{Conv} is likely to be biased toward zero. The reasoning is quite straightforward. In a no-FPE world factor prices will vary inversely with factor abundance. This will cause countries to specialize in the production of goods that use their abundant factors intensively and not produce goods that use their scarce factors intensively. Since a country's technology matrix is based on what is actually produced in that country, countries that are abundant in a factor will use techniques that use more of their abundant factors. Applying this matrix to imports from less endowed countries will overstate the measured factor content of imports for abundant factors and understate it for less abundant factors. This will cause F_{fc}^{Conv} to be biased toward zero because we erroneously think that our imports are produced using the same technologies used at home.

While Davis and Weinstein (1998) demonstrate that F_{fc}^{Conv} is much smaller than predicted factor trade and that these predicted biases in the technology matrices exist, the paper did not explore whether these biases were critical to understanding the missing trade phenomenon. This is because in the Davis and Weinstein work, both the LHS and RHS change as they move across

specifications. In this section, we show that this measurement error alone suffices to generate missing trade.

Rather than work with estimated technology matrices as in our earlier work, we compare F_{fc}^{Conv} with the correct Deardorff-Helpman measure of F_{fc} calculated using the true technology matrices. A plot appears as Figure 1. If the conventional measure of net factor content is close to the true factor content, all of the data will lie on the 45 degree line, or more weakly, will lie in quadrants one and three. A quick scan of the plot reveals this is very much at odds with the data. The magnitude of the conventional measure of net factor trade is much smaller than true net factor trade. The variance of the former is only one-eighth as large as the latter. More surprising yet is that there is, if anything, a *negative* relation between conventional and true net factor trade. Less than one third of the points lie in quadrants one and three.

The fact that the conventional measure of net factor trade is much smaller than the true measure, and the fact that the relation is negative, carries an important message. Efforts to reconcile measured and predicted net factor trade by hypotheses that would alter predicted net factor trade were ultimately doomed. The attenuation bias is so severe that this sufficed to generate the mystery of the missing trade, quite apart from other problems in theory or measurement.

A natural question arises at this point. Nearly all of the studies have used only the US technology matrix. Yet from the theory, there are reasons to believe that the adoption of any common technology matrix will lead to attenuation, for example because it excludes the possibility that there is factor content in intra-industry trade. Hence it is reasonable to ask whether this crippling mismeasurement of net factor trade is a consequence of using the US technology

matrix, or of using any common technology matrix. This is easy to resolve by simply substituting the technology matrices of other countries for that of the US and repeating the experiments. A plot using all available technology matrices appears as Figure 2. The results bear a striking resemblance to those based on the US technology matrix. The conventional measures understate the magnitude of true net factor trade, and indeed maintain the negative relation between the conventional and true measures. The severe mismeasurement of net factor trade is not simply a consequence of the choice of the US technology matrix.

A third issue arises regarding the conventional measure of net factor trade. Theory suggests that the mismeasurement of the factor content of imports is a critical element in generating the attenuation. Hence we should observe the bias even if we apply a country's technology matrix only to its own net trade vector. It is again simple to investigate this by restricting the sample from the last exercise to the cases in which there is a match between the country whose technology matrix is in use and the net trade vector we look at. The plot appears as Figure 3. From the standpoint of the previous literature, the result is very discouraging. The relation between the conventional measure and true net factor trade is absent even when we respectively restrict the sample to the country whose technology matrix we employ.

C. Decomposition of Net Factor Trade and the Role of Intra-Industry Trade

So far we have been looking only at the relation between conventional and true measures of net factor trade. Our results suggest that insofar as there is a relation, it is negative. It is time now to turn to a more formal decomposition in the data. We have noted there are three sources of error. For simplicity of reference, we repeat the decomposition here:

$$\begin{aligned}
F_{fc} &\equiv F_{fc}^{Conv} - \left[\sum_{c'} (B_{fUS} - B_{fc}) T_{cc'}^+ \right] - \left[\sum_{c'} (B_{fUS} - B_{fc'}) T_{cc'}^- \right] + \left[\sum_{c'} (B_{fc} - B_{fc'}) G_{cc'} \right] \\
&\equiv F_{fc}^{Conv} + e_{fc}^{NE} + e_{fc}^{NI} + e_{fc}^{MIT}
\end{aligned}$$

Our discussion will emphasize the last of these errors. It is a commonplace in the theory that the defining characteristic of intra-industry trade is that it is in goods of the same factor intensity because of the assumption that we are in an integrated equilibrium. Hence, matched intra-industry trade, where exports identically equal imports, should have zero factor content. In fact, this relation has been *imposed* in previous empirical tests of HOV, which look only at countries' *net* commodity trade vector. Yet by examining the equation above, and from the fact already observed that countries' technology matrices differ, we can see that this won't be precisely right.

This raises the question of how important a role intra-industry trade plays in carrying out net factor trade. Conventional wisdom based on integrated equilibrium models holds that this term should be small, for two reasons. First, where technologies differ greatly, as in North-South trade, we know there is little intra-industry trade. Second, where we know there is a great deal of intra-industry trade, as in North-North trade, the input coefficients should differ either trivially or randomly. Hence, for intra-industry trade to contribute importantly to true net factor trade, it must be the case that the technology differences are both large and systematic. The conventional wisdom, however, does not hold up if there is specialization of goods within industries and a failure of factor price equalization. In this case, intraindustry trade is likely to be an important conduit of factor service trade because even within industries goods are being produced with different factor proportions.

A simple approach to assessing the importance of intraindustry trade in the export of factor services is to plot the factor content of intra-industry trade, e_{fc}^{MIT} , against the factor content of trade, F_{fc} . If intra-industry trade is unimportant as a communicator of net factor content, then the data should lie along the horizontal axis. In the unlikely case that all net factor content is carried out through intra-industry trade, the data will lie on the 45 degree line. The plot appears as Figure 4. It is striking that intra-industry trade has a much more systematic relation to true net factor content than our traditional measure does. Moreover, the slope of the line is 0.42, indicating that, on average, more than 40 percent of net factor trade is carried out through intra-industry exchange.

A more detailed view may be seen by examining the role of intra-industry trade in total net factor trade for individual countries. There is no *a priori* reason that these terms must have the same sign. But when they do, and when their ratio is less than unity, there is a natural interpretation of this ratio as the share of intra-industry trade in a country's total net trade in a factor. The results appear in Table 1. As it turns out, in 19 of 22 cases, the factor content of intra-industry trade is the same as the overall factor content of trade. By contrast, this was true for only 7 of 22 cases with the conventional measure of net factor trade. The median ratio of factor content of intra-industry trade relative to F_{fc} is 34 percent. This actually understates the importance of intra-industry trade for many countries. In half of the rich OECD countries in our sample, intra-industry trade is more important than inter-industry trade in the net export or import of factor services. Moreover, for France, the UK, and the US, the factor content of intra-industry trade is at least two-thirds as large as total net factor service trade.

This suggests that the profession has operated under a serious misconception. The prevalence of intra-industry trade has been taken as evidence that the factor content of North-North trade is minimal. An unexpected converse is closer to the truth: intra-industry trade is in fact one of the principal conduits of net factor trade. This is true even for the rich OECD countries.

D. Are Factor Service Flows Important?

The previous section shows that the conventional measure of factor service flows is quite small relative to actual flows. This still leaves open the question of how important actual factor service flows are. As we noted earlier, theory does not provide a uniquely appropriate measure. Here we will provide a variety of metrics that will throw light on various facets of the question.

We begin with a simple and intuitive measure. We just scale the absolute value of the net factor trade by the national endowment of a factor. This may roughly be interpreted as the share of the national endowment exported or imported on net. The results of this experiment appear in Table 2. The median in our sample of ten OECD countries is a net trader of approximately 5 percent of its total capital and 9 percent of its total labor. These shares are much higher for Netherlands and Denmark, which export capital services equal to over 10 percent of their capital and import labor services equal to over 15 percent of their labor.

In recent papers, Irwin (1996) and Feenstra (1999) have argued that scaling by a country's total resources (in their case, GDP) may be seriously misleading about the influence of trade within the tradable sectors. This point is underscored by the observation in Davis and Weinstein (1998) that the interaction between non-tradable sectors and the failure of FPE is very important

in reconciling predicted and measured net factor trade. These considerations suggest the value of considering a scaling by national endowments net of resources devoted to non-traded production.⁶ This is implemented easily. If we pre-multiply non-traded output by the relevant technical coefficients, we get the commitment of resources to non-traded sectors, which can be subtracted from national endowments to yield the desired endowments committed to traded sectors.

The results from scaling total net factor trade by endowments devoted to tradables are presented in Table 2. The median country is an absolute net trader of 18 percent of its capital endowment and 36 percent of its labor endowment devoted to tradables. This indicates that for the typical country, net factor trade looms quite large relative to total resources devoted to production of tradables.

E. Special Properties of Net Factor Trade in a No-FPE World

This paper has taken relatively little advantage thus far of the special structure of the underlying theoretical assumption of No-FPE. As it turns out, this assumption imposes a great deal more structure on our predictions than would the conventional HOV model. In the conventional HOV model, a country's net factor trade is well defined relative to all remaining

⁶ Unfortunately, we do not have a perfect breakdown of tradable and non-tradable goods. If we define tradables to include all manufacturing, mining, and agricultural sectors, and define all other sectors as non-tradables, we obtain a rough division. The division is rough because many sectors that we label tradable contain goods traded only with great difficulty (e.g. concrete), and our non-tradable goods sectors contain some that are traded (e.g. Transport and Communication and Finance and Insurance). Even so, using this organization scheme, the median import to domestic-absorption ratio is 0.254 for the tradable sectors and 0.004 for the non-tradables sectors. Furthermore, when looking at the data on a sector-by-sector basis we find that the median import to domestic-absorption ratio is always above 0.12 for our tradables sectors and below 0.05 for non-tradables. This suggests that our classification scheme appropriately captures the differential tradability.

countries taken together, but not typically to any subset of countries. We showed in the theoretical section that in the No-FPE world, there are very definite predictions of the model both bilaterally and relative to subsets of the remaining countries. In particular, it stresses that a Vanek-type chain can be formed, factor by factor, dividing the countries according to whether they are more or less well endowed with a factor than the country in question. The important fact for us here is that the typical country is predicted to be a net exporter of a factor's services to all countries, separately or together, who are less well endowed with this factor, and a net importer of services of this factor from any and all of the countries better endowed with this factor. This special structure allows us to further investigate the empirical robustness of our theoretical model.

The results of this exercise are presented in Table 3. With two factors and two groups for each of 11 countries, there are 40 observations.⁷ In nearly 90 percent of the cases, the model correctly predicts the direction of net factor trade. This is significantly different from a random outcome at all conventional significance levels. This is particularly impressive given that we are predicting that each country will be a net exporter of a factor to one group of countries and a net importer of the same factor from a separate group of countries.

This also suggests one further amendment in our calculation of the role of net factor trade in a No-FPE world. A simple example will make the relevant analytic point. Consider the case of a country that happens to have endowments in nearly the same proportion as the world as a whole. The factor content of its production is nearly proportional to world endowments by market clearing. But identical and homothetic preferences insure that its absorption of factor services is

⁷Countries at the extremes of the abundance distribution always have no trade with more extreme partners so we lose two observations per factor.

exactly proportional to world endowments. With equal endowment mass both above and below the world diagonal, its net factor trade may be quite small. Yet this may mask the fact that it is engaging in a great deal of factor trade both with countries above the world diagonal as well as those below it.⁸

This example suggests breaking up the world into the same two groups, according to whether they are more or less abundant in a factor than a particular country. Absolute net factor contents would then be calculated for the two groups separately and added before scaling. The hope is that this will provide a more appropriate measure of the true role of net factor trade in a No-FPE world. The results of this exercise are presented in Table 3. The results show that this exercise raises measured net factor trade by approximately one-quarter, to a median of approximately 10 percent of total national endowments for capital and 12 percent for labor. If we were instead to scale by endowments in the tradable sectors, the corresponding figures would be 38 percent for capital and 49 percent for labor. These numbers indicate that OECD countries engage in large amounts of factor service trade.

F. Net Factor Trade Within the North

It is often suggested that factor service trade among wealthy countries is relatively unimportant. There is no question that a majority of factor service trade is North-South.

⁸ This example has one trick. Even if the country's endowment were exactly proportional to the world endowment, this would not drive its net factor trade to exactly zero. In fact, the country would be a net importer of both factors! The trick is that this country has a higher share of world income than it would in an integrated equilibrium. We know this by the fact that it has gains from trade although it could replicate (in miniature) the integrated equilibrium. Hence it will be a net importer of both factor services.

However, this does not mean that North-North factor service trade is unimportant. First, when we exclude trade with the rest of the world from our sample, we find the same general pattern of exporting factors to less abundant countries and importing factors from more abundant countries. Indeed in 85 percent of the cases we observe, these OECD countries are displaying this trade pattern. Hence we easily reject the notion that factor endowments are unimportant for understanding North-North trade.

More surprising is the importance of factor service trade within the North. In Table 4 we calculate the ratio of the sum of the absolute value of each country's bilateral factor service trade with the nine other Northern countries to the absolute value of all of its factor service trade. The results indicate that, for the median country, between one-third and one-half of all of its factor trade is with other members of our ten-country sample. For six of our ten countries, factor service trade, in volume terms, is actually more important within our set of nine countries than outside for at least one factor. This result is more surprising when we recall that all trade with the other thirteen OECD members not part of our ten countries is treated here as trade with the ROW.

G. Bilateral Net Factor Trade Country-by-Country

Thus far we have considered trade flows between any given country and the set of countries that are more or less abundant. Our theory, however, suggests that we should be able to cut the data even more finely. When examining bilateral trade between any two countries, the No-FPE model suggests that the net factor service flows should reflect the relative abundance of the two countries in question. If FPE obtains, then there would be no reason to think that relative

abundances would be reflected in bilateral factor trade flows. In Table 3 we examine whether $Sign(F_{fcc'}) = Sign(V_{fc}/s_c - V_{fc'}/s_{c'})$, where $F_{fcc'}$ is country c 's net factor exports to country c' .

As one might expect, there is a slight deterioration in the percentage of sign matches.⁹ Overall, we find that bilateral country factor trade is correctly predicted in 71 percent of the cases. This is significantly different from a coin flip at all conventional levels of significance, indicating that one can reject the hypothesis that endowments are not a factor in determining *bilateral* trade flows. This result by itself is perhaps not that interesting because few would argue that endowment differentials are not important in explaining North-South trade. A stronger null hypothesis is to ask whether one should think of bilateral North-North trade as devoid of factor content. If bilateral North-North trade is devoid of factor content, then the factor content of bilateral North-North trade should be random. In Table XX we repeat our experiment on bilateral factor content of trade by excluding all trade with the ROW. While this result is only significant at the 11 percent level for capital, it is highly significant for labor and for both factors considered jointly. With correct signs in two thirds of the cases overall. The results indicate that we can easily reject the hypothesis that endowments are irrelevant for understanding bilateral trade among wealthy OECD countries. Endowments help us to understand even bilateral trade in the North.

⁹ There are several reasons to believe that the results are likely to be weaker as we move to considering bilateral country data. The first is that we are likely to encounter more noise due to bilateral trade barriers, both political and geographic. Secondly, it is not clear how to handle trade surpluses and deficits. Large surpluses and deficits in countries like the Japan and the US that occurred at this time are likely to cause problems with factor content calculations among relatively similar countries. Third, the previous results implicitly weighted the results by the size of the factor content trade. Small errors in bilateral factor content trade would be offset as along as on average countries export their abundant factors to less abundant countries. This final specification treats small errors the same as large correct predictions.

V. Conclusion

We began this study by arguing that both the theory and empirics of international trade need to move increasingly toward consideration of a non-integrated world. The results we report strongly endorse this suggestion. Our factor content results support the hypothesis of a multi-cone Heckscher-Ohlin model. In this framework, and using countries' true technology matrices, we note that true net factor trade is much larger than reported in previous studies, accounting in part for the "mystery of the missing trade." Net factor contents loom particularly large as a share of resources in traded sectors. Also contrary to integrated equilibrium analysis, intra-industry trade is directly observed to be trade in goods whose factor content varies systematically with measured country factor abundance. Rather than being evidence that there is little factor content of trade, intra-industry trade is actually the conduit for four-tenths of this net factor content for a typical country, and more than two-thirds for some countries, such as the United States. Finally, contrary to what one might expect from the integrated equilibrium framework, net factor trade is both systematic and sizable even among rich OECD countries.

We believe that these results are very much in line with results of other recent studies which are drawing the profession's interest to greater emphasis on a non-integrated world. In this study, we have emphasized the role of relative factor endowments corrected for average efficiency differentials. We would like to stress that nothing that we have done excludes the possibility that product-level Ricardian differences or scale economies models will be important elements of a complete picture of world trade patterns. Indeed, our priors are that such a complete model will almost certainly draw on each of these elements, although identifying the contribution of each must await formal empirical work that places them in a common framework. Our aim here has

been more modest: to show that thinking about world trade, and trade within the North, from a multi-cone Heckscher-Ohlin framework has genuine empirical content.

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Figure 1

F_{fc}^{Conv} vs. True Factor Content of Trade, F_{fc}

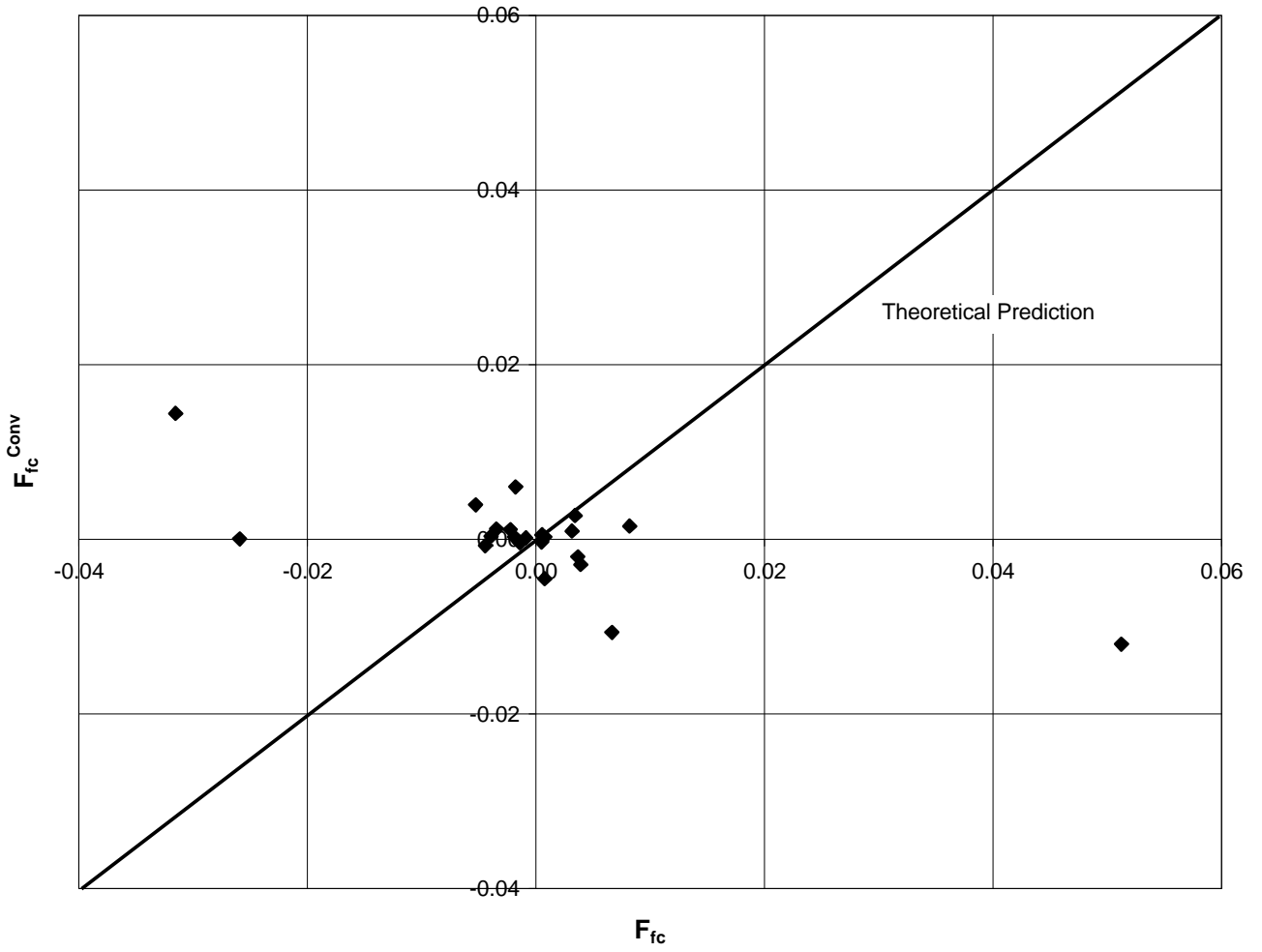


Figure 2

Measured vs. True Factor Content of Trade Using Each Country's
Technology Matrix

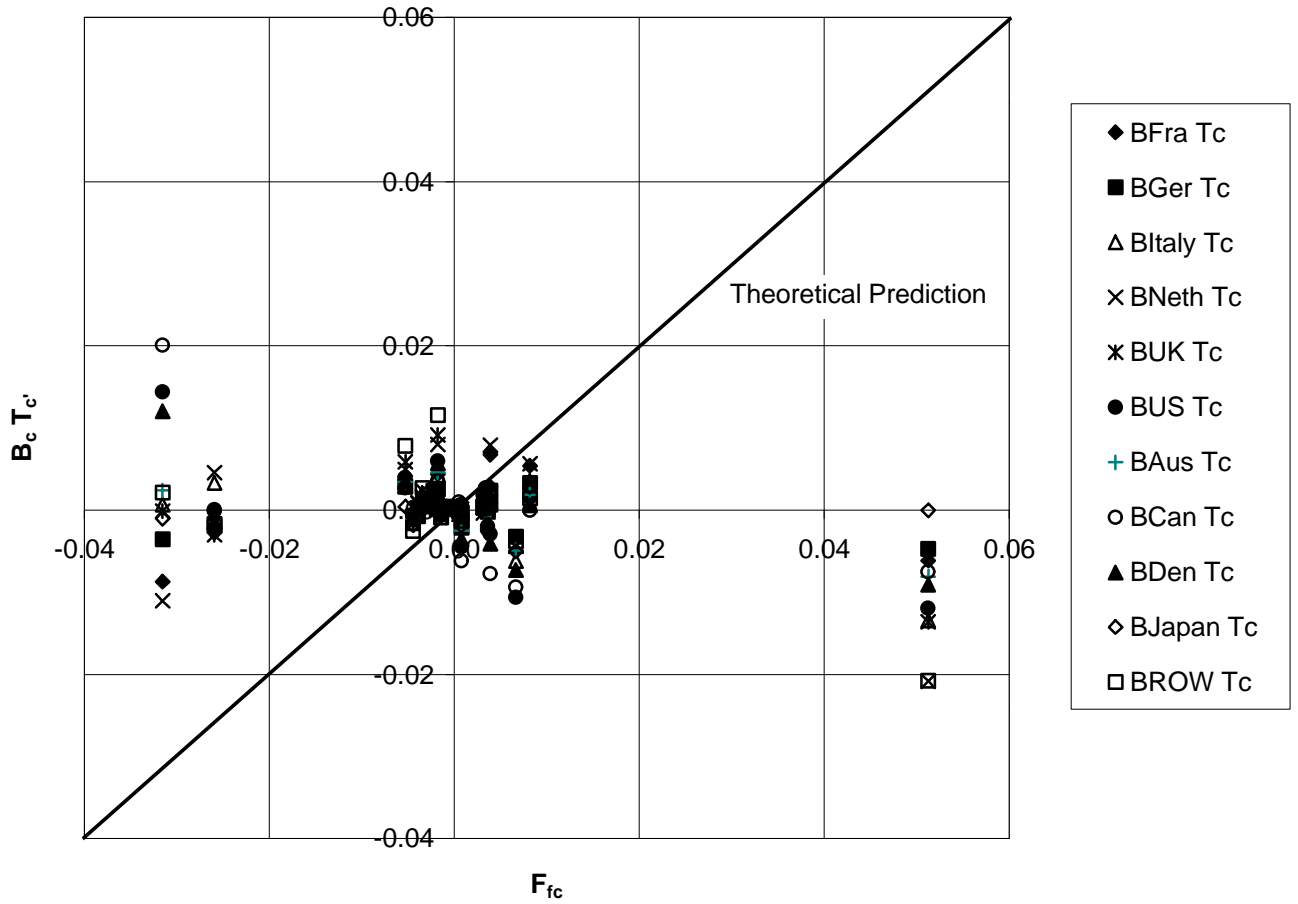


Figure 3

Measured Factor Trade Using Own Technology Matrix v. Actual Factor Trade

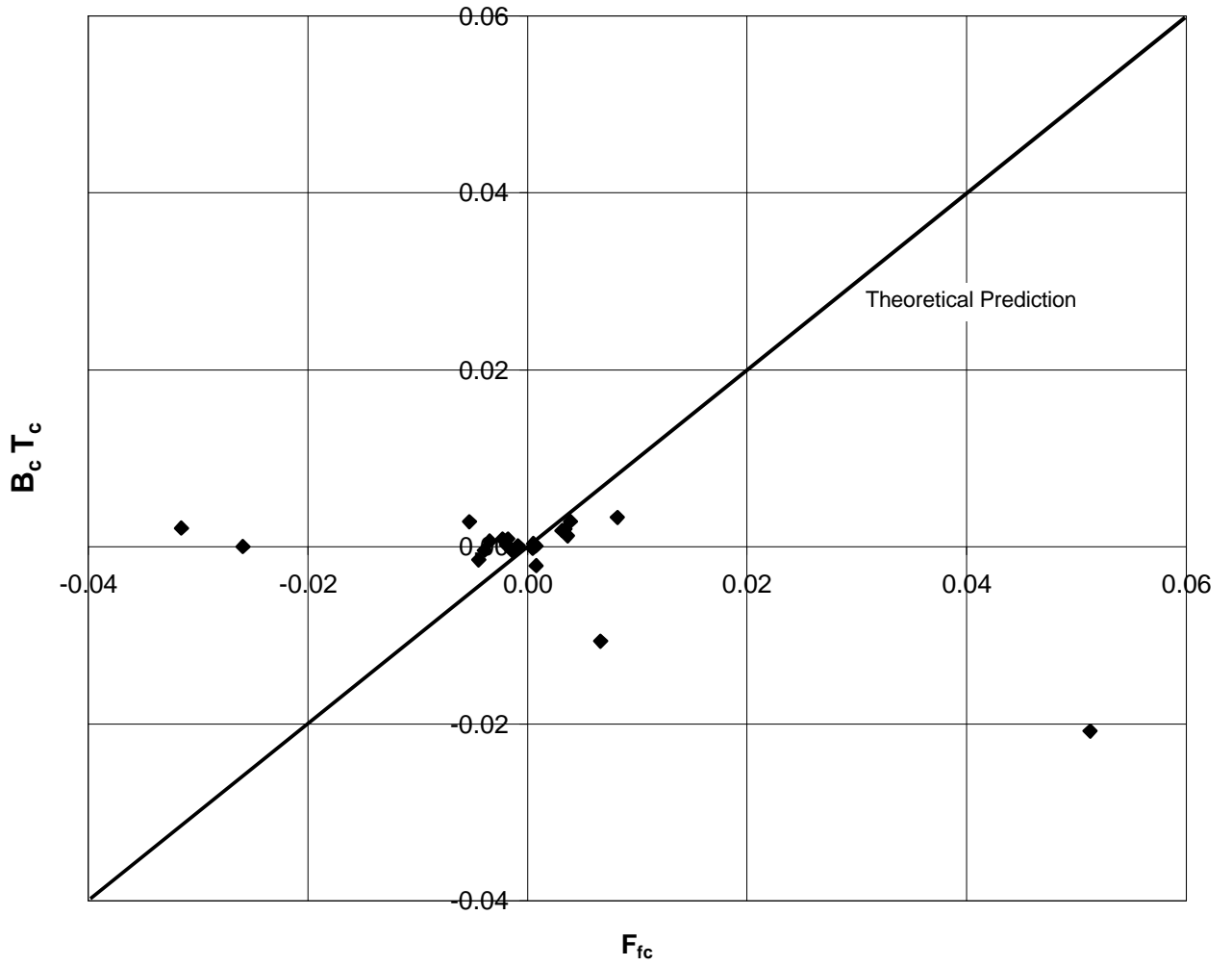


Figure 4

Factor Content of Intraindustry Trade v. True F_{fc}

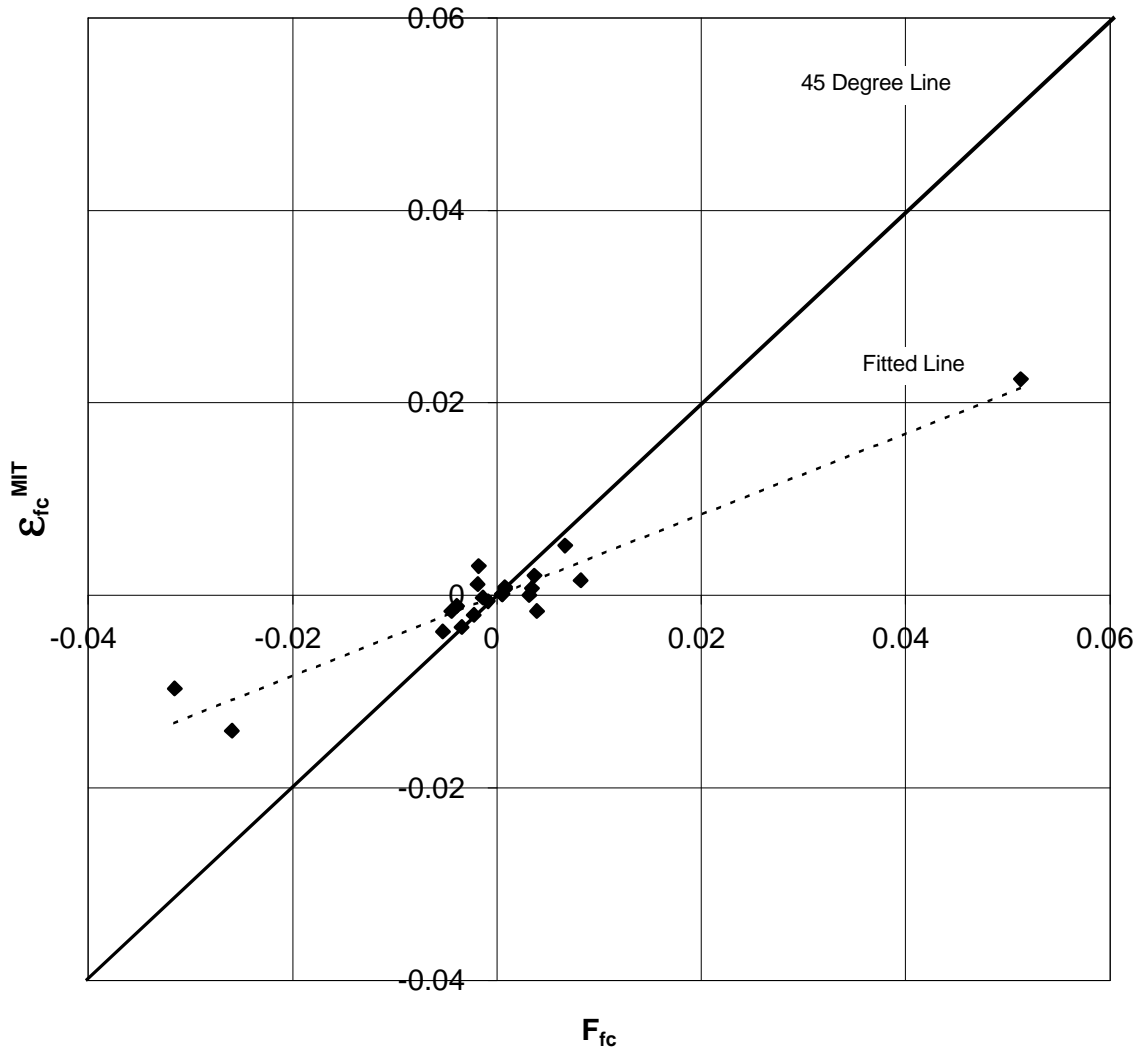


Table 1

The Factor Content of Intra Industry Trade as a
Share of Total Factor Content Trade

	$\frac{e_{fc}^{MIT}}{F_{fc}}$		
	Capital	Labor	Average
Australia	0.24	0.17	0.21
Canada	0.01	-0.61	-0.30
Denmark	0.23	0.68	0.45
France	0.56	0.96	0.76
Germany	0.19	0.71	0.45
Italy	0.84	0.28	0.56
Japan	-0.42	-1.70	-1.06
Netherlands	0.21	0.90	0.56
UK	1.11	0.36	0.74
USA	0.78	0.54	0.66
ROW	0.31	0.44	0.37
Median	0.24	0.44	0.34

Table 2

	Capital	Labor
Median Abs(F_{fc} / V_{fc})	0.077	0.102
Median Abs(F_{fc} / V_{fc}) G10 Only	0.048	0.089
Median Abs($F_{fc} / V_{fc}^{\text{tradable}}$)	0.181	0.357
Median {Abs($(F_{fc}^+ / V_{fc}) + \text{Abs}(F_{fc}^- / V_{fc})$)}	0.098	0.123

Note: G10 refers to the sample of 10 OECD countries for which we have technology matrices. F_{fc}^+ is net factor trade with more abundant countries. F_{fc}^- is net factor trade with less abundant countries.

Table 3

Sign Tests for Trade with More and Less Abundant Countries

	Proportion Correct		Proportion Correct	
	World		Only G10	
	Capital	Labor	Capital	Labor
	Aggregate Data			
Imports Factors from More Abundant Countries	0.7000	1.0000	0.6667	1.0000
Exports Factors to Less Abundant Countries	1.0000	0.8000	1.0000	0.7000
Total	0.8500	0.9000	0.8421	0.8579
p-value	0.0013	0.0002	0.0022	0.0022
	Bilateral Country Data			
	World		Only G10	
	Capital	Labor	Capital	Labor
Imports Factors from More Abundant Partners or Exports Factors to Less Abundant Partners	0.6727	0.7455	0.6000	0.6889
p-value	0.0072	0.0002	0.1163	0.0080
Overall	0.7091		0.6444	
p-value	0.0000		0.0000	

Table 4

Bilateral Net Factor Exports and Imports among the G10
as a Share of Total Factor Exports and Imports

	Capital	Labor
Australia	0.40	0.62
Canada	0.67	0.37
Denmark	0.69	0.37
France	0.26	0.24
Germany	0.37	0.31
Italy	0.81	0.24
Japan	0.82	0.45
Netherlands	0.50	0.30
UK	0.47	0.40
USA	0.39	0.43
Median	0.48	0.37