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TESTING TRADE THEORY IN OHLIN'S TIME

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ABSTRACT

An empirical tradition in international trade seeks to establish whether the predictions of factor abundance theory match present-day data. In the analysis of goods trade and factor endowments, mildly encouraging results were found by Leamer et al. But ever since the appearance of Leontief's paradox, the measured factor content of trade has always been found to be far smaller than its predicted magnitude in the Heckscher-Ohlin-Vanek framework, the so-called "missing trade" mystery. We wonder if this problem was there in the theory from the beginning. This seems like a fairer test of its creators' original enterprise. We apply contemporary tests to historical data on goods and factor trade from Ohlin's time. Our analysis is set in a very different context than contemporary studies—an era with lower trade barriers, higher transport costs, a more skewed global distribution of the relevant factors (especially land), and comparably large productivity divergence. We find some support for the theory, but also encounter common problems. Our work thus complements the tests applied to today's data and informs our search for improved models of trade.

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Factor Abundance Theory in Historical Context

Some years ago scholars in the field of international trade, and perhaps especially the empiricists, might have viewed an invitation to the Ohlin centennial with a sense of unease. Most of us saw factor abundance trade theory as possibly unparalleled in the realm of economic science in its elegance of form and powerful statements on the sources of comparative advantage. At the same time the theory was viewed as having been confounded by empirical contradictions in a series of studies dating back to the paradox unearthed by Leontief.[1] Given such an environment, what kind of conference paper could one offer that would not mar the spirit of celebration?

Happily, at least for the legacy of Ohlin, perspectives do change. In recent years new approaches and extensions to this landmark theory and its empirical testing have attested to its durability and relevance for explaining modern-day trade patterns.[2] In one tradition of empirical research, following Leamer (1984), scholars have constructed large datasets on national endowments and trade patterns so as to measure the link between factors and trade. This is predicted by the theory to be a linear relationship depending on technical coefficients, suggesting that, say, an increase in capital endowment should spill over into trade as an increase in the net export of capital-intensive goods. In another strand of work, following the notation and methodology of Vanek (1968), scholars have focused on the implicit factor trade alone and its relationship to factor abundance (Leamer 1980; Bowen, Leamer, and Sveikauskas 1987). This approach seeks to establish a pass through—in principle, a unit coefficient—relating increments in relative factor endowment directly to net exports of the same factor, as production shifts relative to a stable consumption pattern. Most recent empirical contributions (e.g., Trefler 1993, 1995; Davis and Weinstein 2001) have used the Vanek representation.

These recent works point to a compromise position where the Heckscher-Ohlin theory, augmented in various ways, might better account for the

[1] Leontief (1953a) shocked everyone when he computed a U.S. input-output table for 1947 and discovered that the seemingly capital-abundant and labor-scarce United States was actually engaging in net labor export via trade, with a capital-labor ratio in imports 60 percent higher than exports.

[2] We need not review the whole literature here, but direct the reader to the excellent survey by Helpman (1999) on which we have drawn extensively in what follows.

contemporary pattern of factor trade. To deal with the Leontief paradox one can allow for differences in cross-country productivities, as suggested by Leontief, and implemented empirically by Trefler (1993, 1995). Still this modification alone doesn't get us very far toward narrowing the huge gap between measured and predicted factor trade. Trefler (1995) coined the term "missing trade" to depict the extent to which measured trade is still negligible compared to the prediction of the pure theory.[3] To get an even closer fit, other modifications have been suggested by Trefler (1995) and Davis and Weinstein (2001) such as home bias in consumption, an allowance for nontraded goods, and models without factor price equalization. However, before basking in fresh optimism over how the factor abundance theory has been thoroughly rehabilitated by these various devices, we should note that lurking here is a danger. After so much ornamentation has been added to the model, the skeptics might reasonably ask what is left of Heckscher and Ohlin's original design.

One wonders what Ohlin would make of all these developments and modifications to his theory given his original standpoint. Here was an economist working in the early twentieth century who was inspired to explain the international trade patterns previously witnessed in a largely free-trade regime—the trade of mostly commodity goods and manufactures in the Greater Atlantic economy during the first era of globalization before World War I.[4] And, when Heckscher and Ohlin made their seminal contributions, most observers still hoped that this regime would soon be restored for the long run in the 1920s, though that was not to be.

Heckscher and Ohlin would not necessarily condone the use of their theory in today's very different global economic environment. Today we see numerous barriers to trade (especially in agricultural commodities and simple manufactures), trade in differentiated products and services, and significant intraindustry trade.[5] However, the duo still might be impressed by the substantial technical apparatus that we have developed to evaluate their theory, even as they might regret that they never had easy access to the kinds of large datasets we now take for granted as we implement our sophisticated tests. Given all this, we can imagine one

[3] The same point has been forcefully repeated by Gabaix (1997)

[4] For a study of the era, encompassing trade and factor flows, see O'Rourke and Williamson (1999).

[5] Still, in theories of differentiated products and intraindustry trade, the concepts of Heckscher-Ohlin trade theory endure in basic textbook formulations (Dixit and Norman 1980; Helpman and Krugman 1985).

possible reaction from the fathers of factor abundance trade theory. Might they not call on us to take our considerably refined empirical skills back in time and at least give the theory—and its authors—some kind of a break by testing the model in the historical context for which it was first designed?

Imagining that we heard such a call at the time of Ohlin's centennial, and having a taste for economic history, we thought it would only be fair to him to do just that. Not only does this idea appeal for sentimental reasons, but also, we will argue, it helps resolve questions stimulated by the research on contemporary global factor trade. Testing the model in an earlier historical epoch might help us see the sources of difficulty in applying the model in the present. By bringing to the discussion new datasets from a different economic and political era, we can gain a new perspective. And in some ways, the pre-1914 period offers a better testing ground for the pure Heckscher-Ohlin trade model, as economic historians love to remind us. Indeed, a strand of the economic history literature has already found strong support in that era for several features of standard theory, including predictions of factor price convergence and the pattern of goods trade.[6]

What are the features of the pre-1914 era that make it a better laboratory for testing pure trade theory compared to today? And are there other aspects that favor the present? We know, first, that there were much lower trade barriers then than now, and this could be why the theory fails in the present. In Figure 1 we plot the dispersion of the average applied tariff levels for 1913 and for the post–Uruguay Round period (mid-1990s) for several country samples.[7] Although the 1913 levels are slightly higher than those for the recent period, we must remember that market access negotiations under the Uruguay Round brought tariffs to their lowest point in the entire postwar period, and the theory has usually been tested for earlier periods (the mid-1960s, mid-1970s, or mid-1980s). In addition postwar tariff reductions have been offset, in part or in whole, by an increasing presence of

[6] On factor price equalization, see O'Rourke, Taylor, and Williamson (1996) and O'Rourke and Williamson (1994). On goods trade and factor endowments, see Estevadeordal (1993). We review the latter in the next section.

[7] As a measure of relative dispersion we use box plots representing the interquartile ranges. The line in the middle of the box represents the median or 50th percentile of the data. The box extends from the 25th percentile ($x_{[25]}$) to the 75th percentile ($x_{[75]}$), the so-called interquartile range (IQR). The lines emerging from the box are called the whiskers, and they extend to the upper and lower adjacent values. The upper adjacent value is defined as the largest data point less than or equal to $x_{[75]}$ + 1.5 IQR. The lower adjacent value is defined as the smallest data point greater than or equal to $x_{[25]}$ + 1.5 IQR. Observed points more extreme than the adjacent values are individually plotted.

NTMs (nontariff measures) and other distortionary trade instruments that were practically non existent during the pre-WWI period. In the last three boxplots of Figure 1, we include a measure of the incidence of NTMs based on the percentage of tariff lines (in the tariff schedules) affected by any type of NTM for each country in the sample. It is not a direct measure of the level of protection but highlights the degree of importance of this new type of protectionism. Thus the past epoch might more closely match the free-trade assumptions of the theory.

Second, in the last century certain endowments were very skewed in their distribution, most famously the agricultural land that differentiated the endowments of the New World from the Old. Today, in contrast, many of the countries in the samples studied have very similar endowment patterns, and this leaves little data variation from which to get a strong fit.[8] In the context of standard econometric tests of predicted-versus-measured factor content of trade, such variation would strengthen the test enormously by offering a wide range in the independent variable. In Figure 2 we plot the relative shares of the endowments of the three classical factors—capital, labor, and land—for 1913 and for the late-1980s. Comparing the relative dispersion of the 1913 data with the same sample of countries, or even with a developed country sample, for 1988 (representing then and now most of the world trade), we observe a higher degree of dispersion and skewness in the earlier period. This could be another weak point in tests using modern data.

Third, we note that there was considerable divergence in productivity across countries circa 1913, just as there is today. Over the course of the twentieth century we have seen dramatic productivity convergence within a narrow club of countries—mostly the OECD, and thus much of the Greater Atlantic economy. Yet it is equally true that outside this subset, productivity convergence of the unconditional variety has been weak or nonexistent.[9] In Figure 3, again using

[8] For example, Davis and Weinstein (2001) find inevitably that OECD countries are clustered together with similar capital-labor ratios, a feature arising from those countries' similar levels of development and industrial structures. Their rest-of-the-world data point lies far away from the OECD group, but this gives a great deal of leverage to one point, so much so that it is thought prudent to exclude it from the tests as a sensitivity check. And in terms of data quality, the rest-of-the-world point uses less consistent data, and the required measures have to be constructed by a more fragile procedure.

[9] The first studies of long-run convergence (Abramovitz 1986; Baumol 1986) used the 16-country data of Maddison (1982). Baumol was the first to note the postwar failure of unconditional convergence in wider samples that included less-developed countries. The origin of this failure was first identified by Dowrick and Nguyen (1989); they found conditional

boxplots for different country samples, we report the relative levels of productivity measured as real GDP per capita relative to the United States. The data for 1913 show a high variance of productivity levels when compared with a similar group of countries in 1988 and not much difference if a larger sample is considered. Thus, by doing our tests circa 1913, we are in no way making the problem simpler for ourselves by avoiding an essential ingredient in the "missing trade" puzzle: the possibility of international productivity differences.

Raw differences in factor productivity were postulated by Leontief (1953a) as a possible solution to his paradox for the United States, and his idea was supported in international samples by Trefler (1993, 1995) and Davis and Weinstein (2001). However, as Helpman (1999) notes, this way out just creates another disturbing puzzle: namely where do these differences in productivity originate? In historical work this same disturbing idea was brought to the fore by the controversial work of Clark (1987). He found no comfort in any economic explanation of international variations in the productivity of cotton mills in various countries circa 1913. There seemed to be no compelling economic reason why one New England cotton textile operative performed as much work as 1.5 British, 2.3 German, and nearly 6 Greek, Japanese, Indian, or Chinese workers. After controlling for capital intensities, breakdowns, human capital, learning, and other effects, Clark was forced to admit the possibility of a purely cultural origin of the differences, quite possibly exogenous to the economic system. If Clark's idea holds in a wide range of sectors circa 1913, then, just as output would have been affected by these raw productivity differences, so too would the levels of trade and the factor content therein, with direct implications for our proposed tests.

Finally, we should note a couple of characteristics that work against the earlier period as a good testing ground. First, we must consider the higher transport costs of the past. Like measuring true tariffs from actual import data, measuring true transport costs from trade data is problematic. Comparing CIF and FOB prices then and now might not lead to a big difference in the measured transport cost premium *on goods actually shipped*: goods too expensive to ship never make it into the sample, creating a serious selection problem.[10] Data are

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convergence controlling for investment and population growth, narrowing the problem to a determination of these factor accumulation processes.

[10] This caveat must be kept in mind, even though plenty of evidence attests to the fact that on a wide range of goods shipped before 1914 transport costs in the Atlantic were collapsing over a span of several decades, both on primary products and manufactures. See O'Rourke and Willamson (1994); see also North (1958) and Harley (1988).

scarce here, but it is a reasonable conjecture that many bulk goods shipped today move at a fraction of their cost a hundred years ago, and surely many exotic goods and services can now move more cheaply than they did in the past. Figure 4 illustrates the dramatic declines in transportation and communication costs that have occurred throughout the past century. The second problem for the earlier period—though it is by no means absent in the present—concerns factor mobility. It is well known that the theory predicts that trade and factor mobility are substitutes, and the late nineteenth century was a time of very fluid international factor markets. International labor mobility facilitated the migration of millions of people, especially in the great transatlantic waves from Europe to the New World (Easterlin 1961; Hatton and Williamson 1994, 1998; Taylor and Williamson 1997). The first era of global capital markets functioned very efficiently, reallocating vast sums of capital internationally (Taylor 1996; Obstfeld and Taylor 1998, 2002ab). The presence of endogenous factor movements could well interfere with empirical tests that treat factor endowments as exogenous independent variables. We will return to this issue in our conclusion.

The rest of the chapter is organized around the steps we took to mount such an attack. We focus on the two types of tests used, those based on goods trade and those based on factor trade. We describe the historical data and their manipulation for the test at hand. Results are presented in the usual form for each test and the implications are discussed. A brief conclusion offers some broader interpretations and directions for future research.

Factor Endowments and Product Trade circa 1913

Tests

Consider the standard Heckscher-Ohlin theory, in a world of C countries, I industries, and F factors. Let the output in country c be $\mathbf{X}^c$ $(I \times 1)$. The factor content of $\mathbf{X}^c$ is $\mathbf{BX}^c$, where $\mathbf{B}$ is a matrix $(F \times I)$ of factor content coefficients.[11] Full employment implies that $\mathbf{BX}^c = \mathbf{V}^c$, where $\mathbf{V}^c$ is the factor endowment of country c. Consumption $\mathbf{C}^c$ $(I \times 1)$ in country c equals the country share of world expenditure s^c (assumed equal to world output in this study) times world

[11] In detail, B_{fi} is the direct and indirect use of factor f per unit output of industry i. Direct use refers to factors used as inputs in the given industry; indirect use refers to the factors embodied in the intermediate products used as inputs in the given industry.

consumption $\mathbf{C}^W$. The latter, by world market clearing, equals world output, $\mathbf{C}^W = \mathbf{X}^W = \Sigma_c \mathbf{X}^c$. Hence $\mathbf{C}^c = s^c \mathbf{X}^W$, and the net goods trade $\mathbf{T}^c$ of country c equals $\mathbf{T}^c = \mathbf{X}^c - \mathbf{C}^c = \mathbf{X}^c - s^c \mathbf{X}^W$. If we denote world factor endowment by $\mathbf{V}^W = \mathbf{B}\mathbf{X}^W$, then

$$\mathbf{T}^c = \mathbf{B}^{-1} (\mathbf{V}^c - s^c\mathbf{V}^W). \tag{1}$$

This equation says that trade in each industry is linearly related to factor endowments. We assume that **B** is invertible (i.e., square, with $I = F$). Leamer (1984) argued that the equation need not be restricted to the square case, and he proposed that it be tested by regressions for each industry i. Evaluation centers on the fit and reasonableness of these equations, allowing for both statistical and quantitative significance.[12]

This methodology was used to study trade circa 1913 by Estevadeordal (1993). The challenge was to construct new datasets on net trades (the left-hand side) and endowments (the right-hand side) for the econometric study. A detailed explanation of the data, coding, and aggregation is found in the appendix to Estevadeordal (1997). We provide a brief overview here.

Data, Coding, and Aggregation

Data on net trade for the period circa 1913 were collected for $C = 18$ countries: Argentina, Australia, Austria-Hungary, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, and United States. The sources used were official national reports of trade statistics, originating from such agencies as the Board of Trade (U.K.) or the Department of Commerce (U.S.). The principal problem in ensuring consistency across countries was to set up a universal classification scheme for industries, since, prior to World War II, no standards had been developed and each country used its own classification. The solution was to laboriously construct country-specific concordances that would map each country's sectors into selected sectors of the Standard International Trade Classification (SITC, revised 1961) at the two-digit level. In this way the trade

[12] A potential weakness here is that we do not measure the matrix $\mathbf{B}^{-1}$, but rather estimate it. The specification is loose, and the estimated matrix has totally free parameters that may be unrelated to the true technological coefficients. This weakness is avoided in the factor content approach we use later.

data $\mathbf{T}^c$ was rationalized into a database for $C = 18$ countries and $I = 55$ sectors expressed in U.S. dollars at market exchange rates.[13]

National product estimates were taken from Mitchell (1980, 1983) and Maddison (1995) and expressed in U.S. dollars at market exchange rates, providing the basis for expenditure shares s^c.[14]

Endowment data $\mathbf{V}^c$ for all countries were collected for $F = 5$ types of factor: capital stock, skilled and unskilled labor force, agricultural land, and mineral resources. In Estevadeordal (1993) a proxy for capital stock based on energy consumption of solid fuels was used. The data on energy consumption refer to apparent consumption of primary sources, including net imports of secondary as well as primary energy forms. Because of data availability only solid fuels had been considered (hard coal, brown coal, lignite, and coke). In order to permit aggregation and comparison, data were expressed in thousands of hard-coal equivalents. In this section of the paper we report results based on those of Estevadeordal (1993) which use the original capital measure. However, in order to carry out the subsequent factor content analysis in the next section, we made new capital stock estimates for 1913 using a perpetual-inventory method applied to pre-1913 annual investment rates and real outputs. The results gave capital-output ratios for the terminal year 1913, and multiplying by national products yielded capital stocks in U.S. dollars at market exchange rates. The labor force figures originate in Maddison (1982) and Mitchell (1980, 1983), and we use interpolation between census years as necessary. Agricultural land is measured in hectares, and the data are largely from a study by the League of Nations (1927). Mineral resources are estimated using as a proxy the U.S. dollar value of the annual production of petroleum plus twelve other minerals and ores; quantities are drawn principally from Mitchell (1980, 1983), and prices from Potter and Christy (1962).[15]

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[13] For all the data described in this section, figures were collected for the year closest to 1913. Exchange rates were taken from international compendia of exchange rates, where available, or from national sources.

[14] We do not calculate consumption or expenditure shares directly, but rather assume that they are equal to income or output shares. That is, we set $s^c = \text{GDP}^c/\text{GDP}^w$, and not, following the trade-balance correction of Trefler (1995) as $s^c = \text{C}^c/\text{C}^w$. This correction makes no material difference to our results.

[15] The twelve ores are bauxite, copper, iron, lead, manganese, nickel, phosphate, potash, pyrites, sulphur, tin, and zinc. Some data were also drawn from Rothwell (various issues) and national sources of mineral production for various countries.

Results

The Heckscher-Ohlin equation (1) expresses trade in terms of excess endowments ($\mathbf{V}^c - s^c \mathbf{V}^W$). For empirical purposes, following Leamer (1984), we can regress trade on endowment supplies alone.[16] We report results at two different levels of aggregation (six and forty-six commodity groups).

Table 1, Panel (a), reports the estimates for the following six commodity groups: agricultural products, raw materials, capital-intensive goods, labor-intensive goods, machinery, and chemicals. The R^2 measures of fit are typically very high, and most of the estimated coefficients are correctly signed and statistically significant. The coefficients still depend on the units of the explanatory variables. Since we are not only interested in the statistical significance of a coefficient but also in knowing how important each of the variables is in explaining the trade pattern, Panel (b) reports β values for each of the five explanatory variables for each trade aggregate considered.[17] If we select arbitrarily, as in Leamer (1984), 1.0 to define a significant β value, then capital is significant five times, land four times, and labor-skilled and minerals three times.

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[16] The Heckscher-Ohlin model of trade can express trade in terms of endowment supplies or in terms of excess endowment supplies. In a 2×2 version the equations of the model are

$$T_1 = \beta_{1L}\,(L - Y\,L^w/Y^w) + \beta_{1K}\,(K - Y\,K^w/Y^w);$$
$$T_2 = \beta_{2L}\,(L - Y\,L^w/Y^w) + \beta_{2K}\,(K - Y\,K^w/Y^w);$$
$$Y = w_L L + w_K K;$$

where T_1 and T_2 are net exports of the two commodities, Y is GNP, L is labor, K is capital, w_L and w_K are factor returns, the w superscripts refer to the world, and the β are Rybczynski coefficients. This form of the model expresses net trade as a linear function of excess supplies of factors. However, excess factor endowments are a linear function of all factor supplies: that is, $L - Y\,L^w/Y^w = L - (w_L L + w_K K)\,L^w/Y^w$. Thus, for almost all distributions of K and L, these excess supplies are correlated, and a regression of trade on a subset of the excess supplies will yield biased and inconsistent estimates. This problem will be compounded if there are measurement errors. Because of this problem a reduced form of the model is preferred in empirical studies. This reduced form is found inserting the GNP equation into the net exports equations:

$$T_1 = \beta_{1L}\,L + \beta_{1K}\,K;$$
$$T_2 = \beta_{2L}\,L + \beta_{2K}\,K;$$
$$Y = w_L L + w_K K.$$

[17] A β value is equal to the estimated coefficient times the ratio of the standard deviation of the explanatory variable divided by the standard error of the dependent variable (Maddala 1977; Leamer 1978). These β values are directly proportional to the contribution that each variable makes to a prediction of net trade. These values indicate the amount of change in standard deviation units of the net trade variable induced by a change of one standard deviation in the factor endowment. A β value of 0.1 is small, since a change of one standard deviation in the resource would have a hardly perceptible effect on net exports, but a value of one can be regarded as large.

Generally speaking, in the estimates of Table 1, comparative advantage in agricultural products is associated with abundance of land and mineral resources and is negatively related to capital. Trade in raw materials owes comparative advantage to the availability of capital and unskilled labor; land and skilled labor contribute to comparative disadvantage. The sources of comparative advantage in manufacturing are, in general, as expected. Capital is a source of comparative advantage for capital-intensive goods and machinery. Mineral resources are important for labor-intensive and chemicals groups. Skilled labor also contributes to comparative advantage in all manufacturing groups. The β values indicate, again, that the contribution is most important in labor-intensive and chemicals products, followed by capital-intensive goods and machinery. Net exports of all manufacturing groups are negatively associated with the supply of land.[18] We also performed some sensitivity analysis on these results.[19]

Table 2, Panel (a), reports results from Estevadeordal (1997) where a more disaggregated Heckscher-Ohlin model was estimated with the goal of obtaining measures of trade protection by sector. Based on the reported *F*-statistics, thirty-seven out of the forty-six net trade regressions are significant. Moreover most of the R^2 measures of fit are very high. For individual factor endowments, out of forty-six estimated equations, capital has significant coefficients (at the 10 percent confidence level) in twenty-six cases, skilled labor in fourteen, unskilled labor in only seven, land in twenty-nine, and mineral resources in twenty-seven. The β values are reproduced in Panel (b).

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[18] Results such that agricultural land have a negative impact on the comparative advantage of all manufacturing groups should not be surprising. Although the model used here appears to require that all factors be used in all industries, this is not the case. The existence of industry-specific factors implies that particular elements of the factor requirements matrix **B** may be zero. For example, in a model with two inputs, labor (L) and land (M), and two goods, agricultural (X_1) and industrial (X_2), if land is not used to produce the industrial commodity, the B_{M2} element of matrix **B** will be zero. It can be easily shown that although both labor and land are used to produce the agricultural good, the output of agricultural goods depends only on the endowment of land. And although land is not used to produce industrial goods, the level of output of industrial goods depends on both the endowment of labor and the endowment of land. This apparently paradoxical result stems from the fact that full employment requires that land must be fully utilized in the agricultural sector. This fact, together with the fixed input requirement B_{M1}, determines the level of agricultural output M / B_{M1}. Since the labor residual left over for industrial production is then dependent on the endowment of land (i.e., $L - X_1 B_{L1} = L - M B_{L1}/B_{M1}$), it becomes obvious that the level of industrial output is also dependent on the endowment of land.

[19] To test for the robustness of these estimates, sensitivity analysis was performed. Influential observations were identified using the extreme *t*-statistics of dummy variables that select a single country and that are included in the equation one at a time. In general, however, the coefficients in Table 1 with high *t*-statistics are insensitive to the omission of those observations.

In general, capital and skilled labor are sources of comparative disadvantage for primary product trade. Capital is a source of comparative advantage in most capital-intensive goods; it is a source of disadvantage in labor-intensive commodities, where skilled labor contributes to comparative advantage. Agricultural land is consistently a source of advantage for primary products and creates comparative disadvantage in manufacturing. Interestingly mineral resources are a source of comparative advantage in the processed agricultural products group and in almost all manufactures. Using the conventional 0.5 level to define a significant β value, capital is significant in thirty-six out of forty-six net trade equations. [20] Skilled labor is significant twenty-four times, unskilled labor only four times, agricultural land thirty-eight times, and mineral resources thirty-six times.

Summary

In this section we have shown how it is possible to implement a test circa 1913 of the Heckscher-Ohlin prediction that there exists a linear relationship between factor endowments and the net trade of goods. The results are very favorable to the hypothesis. For most goods the fit is acceptably good, and many coefficients have statistical significance. Moreover, once we compare the signs of the coefficients for each type of good with what we expect—based on whether certain goods are intensive in certain types of factor—we also find a reassuring correspondence between the econometric results and our intuition. Finally, using the technique of β coefficients to see how much the variation in factor endowments explains the variation in net trade, we find that the quantitative significance of the model is also very high. In short, having appealed to the 1980s vintage of empirical trade tests of the form pioneered by Leamer (1984), we have found a good deal of correspondence between the empirical results of the past and present. In both cases the fit of the model is good, and it is quite a bit stronger in the historical data from Ohlin's time. Thus, viewed from a 1980s empirical perspective, the factor abundance theory seems to work very well in its own time. We now ask whether the same holds true from a 1990s perspective, where attention has shifted to tests based on factor content.[21]

[20] In highly disaggregated studies, 0.5 is usually used as a threshold for a β value to be considered significant (see Leamer 1984; Saxonhouse 1986).

[21] The next section draws on Estevadeordal and Taylor (2002).

Factor Endowments and Factor Trade circa 1913

Tests

The factor content test is based on the immediate precursor of equation (1) which does not depend on any assumptions about the dimensions or invertibility of the matrix **B**, namely

$$\mathbf{B}\mathbf{T}^c = \mathbf{V}^c - s^c\,\mathbf{V}^W. \tag{2}$$

Here the left-hand side vector is the measured factor content of trade (denoted MFCT_f) and the right-hand side is the predicted factor content of trade (denoted PFCT_f). In this methodology all parameters in equation (2) are measured, none are estimated econometrically, and the test centers on whether the equation holds. Thus the method is harder to implement because its data requirements are considerably larger, which might explain why cross-country tests of this type have only appeared relatively recently.

Testing equation (2) can take a variety of forms, as outlined by Davis and Weinstein (2001). Four tests have been deployed, usually one factor at a time and using the set of countries *c* as the sample:

- The *sign test* focuses on whether, the direction of MFCT_f matches that of PFCT_f. In equation (2) this amounts to asking whether the sign of the left- and right-hand sides are equal. The results are displayed in terms of the fraction of correct predictions.
- The *variance ratio test* asks whether the variance of MFCT is as large as PFCT. Of course, if the theory were a perfect fit, the ratio of the variances of the left- and right-hand sides of equation (2) would be unity.
- The *slope test* depends on a regression of MFCT on PFCT. One can calculate the slope coefficient and its significance level from a regression of the left-hand side of equation (2) on the right-hand side. Again, if the theory were a perfect fit, the slope would be unity.
- The *t-test* reports the *t*-statistic for the slope test where the null is a zero slope. This test can detect a positive and significant relationship of endowments to trade, although the relationship need not be one for one.

Data, Coding, and Aggregation

As in the previous tests, we will still need each country's trade and factor endowment data ($\mathbf{T}^c$ and $\mathbf{V}^c$), and for these we draw on the data described in the previous section for C = 18 countries, I = 55 sectors, and F = 4 factors.

We also need a factor use matrix **B**. In general, when there are intermediate goods, **B** depends on the direct factor use matrix $\mathbf{B}^d$ and the input-output matrix **A**. Calculating $\mathbf{B} = \mathbf{B}^d(\mathbf{I} - \mathbf{A})^{-1}$ is straightforward if data on technology can be found to construct $\mathbf{B}^d$ and **A**. In the pure version of the theory and empirics, it is assumed that **B** is constant across countries. The objective can then be easily met if we can construct **B** for just one country and, like Trefler (1993, 1995), we pick the United States as the source of the **B** data.

The direct factor use matrix $\mathbf{B}^d$ for the United States is taken from the study of Eysenbach (1976), as employed by Wright (1990). She used the BLS-Leontief 1947 input-output table and a 165-industry classification. Her capital and labor coefficients came from the census of 1899, and her natural resource coefficients, via Vanek (1963), from the 1947 input-output table. Capital input is a stock measure in U.S. dollars that we take as corresponding to our endowment definition, up to a deflator. She measures nonrenewable resource inputs in the same units (dollars) as our endowment measure of mineral resources, up to a deflator.[22] However, her renewable resources measure is not the same (neither in definition nor in units) as our endowment category of agricultural land. This will invalidate some of our tests for this case: consistent units are needed for a meaningful benchmark of unity in the slope coefficient and variance ratio tests. Thus in the construction of **B** from $\mathbf{B}^d$ we will have four factors, but not an exact match to the structure of the endowment data.

Our final data collection task was to find a suitable input-output matrix **A**. We used Leontief's input-output table for 1919 (Leontief 1953b), built around a classification scheme of only 41 industries. Considering the extent of the overlap and consistency between the various classifications, it was decided to settle finally on a 25-industry aggregation scheme for the present exercise. Thus two sets of concordance mappings were constructed, one from the 165-industry classification to the 25 new industry classes, and one from the 41-industry classification to the 25 new classes. Our previously constructed vectors and matrices $\mathbf{T}^c$ and $\mathbf{B}^d$ were converted to this $I = 25$ classification by some simple arithmetic aggregation, and $\mathbf{B} = \mathbf{B}^d (\mathbf{I} - \mathbf{A})^{-1}$ was calculated.

[22] Here we are careful to modify our endowment measures $\mathbf{V}^c$ to include coal, so as to match Eysenbach's data. This is a slight change from the original Estevadeordal data used in the previous section where coal was a proxy for capital.

Results

Table 3, upper panel, and Figure 5, show the results of applying the four basic tests (sign, *t*, variance ratio, and slope) to the raw data for eighteen countries, for four individual factor types plus a set of pooled factor types. In cases where the factors are pooled, we need to worry about the commensurability not only on each side of the equation but also from one type of factor to the next. Units of, say, labor and capital, will never be commensurate in a physical sense, but econometric adjustments are needed to permit valid estimation, specifically to ensure homoskedasticity. Following Trefler (1995), we weight each observation by $\omega_{fc} = 1/(\sigma_f s_c^{1/2})$, where the σ_f are the standard deviations of the pure Heckscher-Ohlin-Vanek error $MFCT_{fc}–PFCT_{fc}$ for each factor f, and where s_c is an adjustment for country size.[23]

The results are, at best, mixed, and perhaps a little disappointing. They are, in this regard, comparable with the mid-1990s empirical findings of Trefler (1993, 1995) and Gabaix (1997). For capital and labor all the tests offer almost no support for the theory. The sign test reveals a predictive power no better than a coin flip. The *t*-tests are insignificant and often of the wrong sign. The variance ratio and slope tests confirm that the fit is very poor, the slope is almost a horizontal line, and overall the model can explain maybe 1 percent of the overall variance of the dependent variable.

So far so bad, but our hopes pick up a little bit when resources are considered. For renewable resources, the noncommensurability problem confines us to the sign test and the *t*-test, but the results are more favorable. The sign test rises to 67 percent, and the slope is significant and positive. For nonrenewable resources, we can run the full battery of tests, and we find the best fit of all. The sign test shows that we get the direction of trade right for this factor in almost four out of every five cases, the *t*-ratio is a respectable 2.4, the variance ratio is 38 percent and the slope is 0.35. Finally, what the regressions are telling us can also be shown graphically, and Figure 5 depicts the scatter plots for the five cases (from Table 3, upper panel). The poor fit for labor and capital is immediately apparent given the diffuse cloud of dots seen in each case. For resources, the basis for a tighter fit is also clearly visible, and the pooling is a mélange of the two.

[23] We also tried the Gabaix (1997) weights $\omega_{fc} = 1/s_c$ and the Davis-Weinstein (2001) weights $\omega_{fc} = 1/V^W_f$ and found little difference. See Estevadeordal and Taylor (2002).

Such results, though disappointing, are not too surprising given the equally weak findings of the recent literature using the basic, unadorned specification of the Heckscher-Ohlin-Vanek hypothesis. Accordingly various enhancements of the basic specification have been proposed. These looser specifications appeal to theory as a basis for adding additional parameters that allow for a better fit: for example, adjustments for factor productivity differences and home bias in consumption. We applied each of these refinements to the historical data (Estevadeordal and Taylor 2002). Our research indicates that the home bias adjustment makes no more sense in the historical context than it does in the recent data, and we find very perverse parameters (e.g., Trefler 1995). The Leontief-style productivity adjustment does find support, though, as we can see from the lower panel of Table 3, it does not eliminate the missing trade problem for capital and labor.[24]

By our reading, these productivity adjustments do help the model fit better, confirming the findings on contemporary data (Trefler 1993, 1995; Davis and Weinstein 2001). The sign tests starts to rise well above the coin-flip level for capital, and improves somewhat for renewable resources. The slope for nonrenewable resources also rises, doubling to the level of about 0.6, and the variance ratio rises to a favorable 0.51. However, the joy is short-lived, since the slope and variance ratio tests are still demoralizingly low for both capital and labor. The pooling of the results does not add a great deal to the analysis. With pooling the tests come out somewhere in between the good results for nonrenewable resources and the poor results for labor and capital, as expected.[25] All in all, productivity adjustment appears to be a useful and necessary step, but it is not a solution to the missing trade problem.

[24] Trefler (1993, 1995) showed that a way to correct for this problem is to rescale the endowment vector V_{fc} by some measure of relative productivity. If such a productivity correction δ_c is common to all factors in one country, then we would arrive at a productivity-corrected endowment vector of the form $\tilde{V}_{fc} = \delta_c V_{fc}$, and the analysis can then proceed as before. We use two proxies for δ_c, the relative GDP per capita (following Trefler) and the relative real wage. In each case we set U.S. equal to 1, since we are using the U.S. factor-use coefficients on the left side. GDP per capita measures were taken from Maddison (1995) and real wages from Williamson (1995). See Estevadeordal and Taylor (2002).

[25] We have also repeated the exercise by estimating, rather than imposing, the implied technology shift parameters. In this method the parameters δ_c are chosen to maximize the fit of modified Heckscher-Ohlin-Vanek equation, subject to the normalization that $\delta_{US} = 1$. See Estevadeordal and Taylor (2002).

Summary

In this section we have shown how it is possible to implement a test circa 1913 of the Heckscher-Ohlin-Vanek prediction that there exists a linear relationship between factor endowments and the net factor content of trade. The results are not very favorable to the hypothesis. For labor and capital, the fit of the model is close to nonexistent. For resources, there is evidence that the model fits—though we are hampered by a units problem that prevents us from fully testing the predictions for renewable resources. For all factors, the fit of the model is improved by a Leontief-style productivity correction. In short, having appealed to the 1990s vintage of empirical trade tests of the form pioneered by Trefler (1993, 1995), we have found a good deal of correspondence between the empirical results of the past and present. Missing trade is everywhere, though it is less absent in the case of resources than in the cases of labor and capital (Gabaix 1997). It is also less absent than in the present. Thus, the simple factor content approach seems to work not much better in its own time than it does today—that is, not very well at all. Our study brings us to a point that corresponds to the year 1995 in the contemporary empirical literature—the year Trefler announced the mystery of the "missing trade." In the conclusion we ponder where we can go from here

Conclusion: Give Heckscher and Ohlin a Break!

This work has looked very broadly at the applicability of modern tests of the Heckscher-Ohlin trade theory to the historical data for 1913, an earlier period of relatively well-integrated goods markets and a time in history that inspired the creators of the factor-abundance model. The results of this exercise have been mixed. The relationship between factor endowments and goods trade appears strong, even stronger than that found in contemporary data. But the factor content tests perform as poorly as they do on recent data, although a Leontief-style productivity correction can go some way toward correcting the problem. Even then, the best fit in 1913 seems to be for resource endowments, rather than for capital and labor.

Though we are disappointed to find such weak evidence, is this cause to dismiss the Heckscher-Ohlin model? We think not. First, on empirical grounds, we are not fully satisfied with the methodology adopted here, and, compared to the most recent advances in the field that have attained a close match between theory and data, we have many gaps in our data. The Davis and Weinstein (2001) analysis goes further than any previous work in achieving a satisfactory fit, but their OECD data allow them to investigate different factor-use matrices **B** for each country. In contrast, we have been limited to only one factor-use matrix **B** for the United States in 1913. It would be a very difficult, almost impossible, data collection exercise to build full set of input-output tables and production-consumption accounts for even just these 18 countries at a 25-sector level circa 1913. Still such an effort would be necessary to advance beyond the circa 1995 econometric approaches that we have employed here.

Notwithstanding these methodological constraints, what can we say about the interpretation of our results when they are taken at face value? Gabaix (1997) protested that the good fit of the Heckscher-Ohlin-Vanek model on natural resources today was cold comfort, since such endowments constitute such a paltry share of world output in the modern, service-oriented, knowledge-based economy. In today's world the bulk of factor rewards accrue to capital and labor (mostly skilled, i.e., human capital). Such objections are clearly less relevant in 1913, when much of the basis of world trade, and still significant portions of world output, were based on primary producing activities.

The role of resources, and the good fit of the model there, also brings us back to the point made in the introduction: the Heckscher-Ohlin theory supposes that factors are not mobile and endowments are exogenous. Only then would estimation be valid. Note that these shortcomings are econometric problems, not a failure of the theory itself. Indeed, the theory very usefully predicts that trade and factor migration can be substitutes. This brings us back to the nature of the world economy in 1913. It was not just a world of relatively free trade; it was also a world with a high degree of factor mobility. Capital mobility is potentially a problem today for factor content tests, but in 1913 we have an even bigger problem, for both labor and capital were highly mobile then. These are the factors for which the fit of the Heckscher-Ohlin-Vanek model is weakest in our data—a coincidence? We think not. The fit of our model is strongest for the immobile factors that have long been considered the key source of comparative advantage in the late nineteenth and early twentieth centuries.[26]

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[26] In a paper entitled "Give Heckscher and Ohlin a Chance!" Wood (1994a) raised this concern in connection with contemporary tests of the theory that ignore the fact of considerable international capital mobility that can equate rates of return across countries. Instead, he argues, we must restrict attention only to the factors that are basically immobile, resting his case on the theoretical work of Ethier and Svennson (1986). Land being problematic to measure, Wood's research agenda has focused on skilled and unskilled labor as the key contrast in his "North-

In summing up, we urge caution before interpreting poor static regression results as providing evidence against the theory for this historical period. A large literature in economic history has drawn attention to capital and labor flows in the greater Atlantic economy of that era (Taylor and Williamson 1994, 1997; Hatton and Williamson 1994, 1998; O'Rourke and Williamson 1999; Williamson 1995; Edelstein 1982; Obstfeld and Taylor 1998, 2002ab). Until an econometric strategy can be found that adapts the factor-content tests to cope with this simultaneity problem we should, perhaps, give Heckscher and Ohlin a break.

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Table 1
Tests of Factor Endowments and Product Trade

(a) OLS estimates	Capital	Labor-skilled	Labor-unskilled	Agricultural land	Minerals	R^2	Adjusted R^2
Agricultural products	-7.6***	-26.3	-31.9	8.5**	4.5***	.81	.73
	(-5.22)	(-1.74)	(-0.55)	(2.38)	(4.50)		
Raw materials	2.7***	-20.6***	41.6*	-3.0***	0.4	.78	.69
	(5.22)	(-4.61)	(2.14)	(-4.91)	(1.67)		
Capital-intensive goods	2.1***	18.4***	13.3	-6.5***	-0.7*	.83	.77
	(5.98)	(4.21)	(0.66)	(-4.98)	(-2.08)		
Labor-intensive goods	-0.9***	17.8***	-9.8	-4.0***	0.8**	.65	.51
	(3.20)	(8.89)	(-1.24)	(-3.79)	(2.59)		
Machinery	1.1***	5.0*	-9.6	-3.1***	0.08	.91	.88
	(4.73)	(2.12)	(-1.05)	(-5.87)	(0.54)		
Chemicals	-0.1	6.7***	-6.3	-2.3***	0.38	.69	.56
	(-1.08)	(5.87)	(-1.62)	(-2.53)	(1.72)		

(b) β values	Capital	Labor-skilled	Labor-unskilled	Agricultural land	Minerals
Agricultural products	-1.83	-0.51	-0.11	0.72	1.64
Raw materials	2.36	-1.45	0.50	-0.92	0.53
Capital-intensive goods	1.30	0.92	0.11	-1.42	-0.65
Labor-intensive goods	-1.10	1.76	-0.17	-1.73	1.48
Machinery	1.22	0.45	-0.15	-1.22	0.13
Chemicals	-0.24	1.29	-0.21	-1.93	1.37

Notes: *t*-ratios in parentheses. (***) denotes significant at the 1% level. (**) denotes significant at the 5% level. (*) denotes significant at the 10% level. Commodity groups based on SITC rev. 1, 2-digit codes: Agricultural products (Groups 0, 1, 2 except 27 & 28, 4); raw materials (Groups 27, 28, 3 & 68); capital-intensive goods (Groups 61, 62, 63, 64, 651-655, 67 & 69); labor-intensive goods (Groups 656, 66 & 8); machinery (Group 7); and chemicals (Group 5).
Source: Estevadeordal (1993).

Table 2
Tests of Factor Endowments and Product Trade (Disaggregated Data)

(a) OLS estimates	Capital	Labor-skilled	Labor-unskilled	Agricultural land	Minerals	R^2	Adjusted R^2	$F(6,11)$
SITC Group 0: Food and Live Animals								
00	0.06*	-0.67**	-0.25	0.80**	-0.21**	0.66	0.48	2.52
01	-1.34**	0.60	-12.12*	1.88**	0.54**	0.79	0.69	7.30**
02	-1.03**	0.18	-8.37	1.79**	0.20*	0.75	0.62	5.62**
03	0.10**	-1.13**	-1.41**	0.33**	-0.10*	0.39	0.06	1.17
04	-1.16**	-8.52**	-17.8*	5.2**	0.18	0.90	0.85	17.53**
05	-0.42**	-0.74	7.21*	1.26	-0.20	0.68	0.50	3.90**
06	-0.64**	1.11	-4.02	-0.29	0.45**	0.58	0.35	2.55
07	-0.28**	-2.13**	1.50*	0.08**	0.06**	0.98	0.97	137.11**
08	-0.00	0.09	0.07	0.43**	-0.06**	0.70	0.54	4.36**
09	-0.28**	0.51*	-2.33*	0.16**	0.12**	0.73	0.59	5.08**
SITC Group 1: Beverages and Tobacco								
11	0.06*	-1.22**	6.45**	-0.24**	0.039*	0.70	0.54	4.41**
12	-0.06**	-0.43**	-0.16	0.07	0.06**	0.78	0.66	6.70**
SITC Group 2: Crude Materials, Inedible (Except fuels)								
21	0.20**	-0.40*	-0.56	0.88**	-0.22**	0.96	0.94	46.34**
22	0.13*	-5.80**	3.72	1.27**	-0.15	0.74	0.61	5.48**
23	-0.59**	1.44**	-3.28**	0.08	0.16**	0.96	0.94	49.54**
24	0.06	-3.83**	-3.0*	1.76**	-0.21**	0.72	0.57	4.83**
25	-0.16**	0.27	-2.80**	0.16**	0.06**	0.58	0.35	2.55
26	-1.27**	-17.24**	-4.11	5.64**	0.66*	0.79	0.68	7.25**
27	0.00	-1.04**	2.02**	0.07	0.01	0.22	0.10	0.53
28	-0.46**	-0.28	-4.29**	1.46**	-0.08	0.84	0.76	10.06**
29	-0.02	-2.27**	2.87	0.66**	-0.06**	0.62	0.41	3.04
SITC Group 3: Mineral Fuels, Lubricants and Related Materials								
32	2.02**	-8.33**	22.71**	-2.64**	-0.21**	0.89	0.83	15.04**
33	0.17**	-4.13**	2.15	0.88**	0.04	0.86	0.78	11.42**
SITC Group 4: Animal and Vegetable Oils and Fats								
41	-0.03	-0.44	-1.43	0.68**	-0.11**	0.70	0.53	4.31**
42	-0.20**	0.73**	-0.46	-0.11*	0.12**	0.80	0.69	7.35**
43	-0.03**	0.03	-0.21	0.02**	0.01**	0.74	0.60	5.40**
SITC Group 5: Chemicals								
51+52+53+55+59	0.04	0.82*	-0.17	-0.54**	0.03*	0.74	0.59	5.23**
54+56+57+58	0.03**	-0.04	0.45	-0.24**	0.05**	0.66	0.47	3.58**
SITC Group 6: Manufactured Goods Classified Chiefly by Material								
61	-0.42**	2.49**	-5.08**	-0.20*	0.25**	0.82	0.73	8.71**
62	-0.06**	1.04**	-0.61*	-0.19**	0.05**	0.80	0.69	7.35**
63	-0.90**	2.24**	-6.96*	0.23	0.41**	0.77	0.64	6.14**
64	-0.21**	1.08**	-2.18**	-0.39**	0.21**	0.70	0.54	4.42**
65	2.25**	10.86**	17.1	-3.74**	-1.23**	0.86	0.79	12.22**
66	-0.11	1.31	-8.69**	-0.80**	0.18**	0.69	0.52	4.12**
67	0.73**	0.80	10.93	-3.28**	0.37**	0.83	0.74	9.15**
68	-0.15**	-3.98**	1.60	0.94**	0.11	0.77	0.65	6.35**
69	0.21**	1.16*	2.61	-1.95**	0.38**	0.84	0.76	10.23**
SITC Group 7: Machinery and Transport Equipment								
71	0.84**	-2.82**	5.18**	-1.50**	0.17**	0.94	0.91	29.85**
72	0.08**	0.30	0.44	-0.75**	0.16**	0.87	0.80	12.49**
73	0.24**	2.21**	-0.12	-0.48**	-0.06**	0.94	0.91	31.32**
SITC Group 8: Miscellaneous Manufactured Articles								
81+83+85	0.11**	-0.08	1.19*	-0.40**	0.06**	0.88	0.82	14.65**
82	0.02**	-0.04	0.52**	-0.05**	-0.00	0.59	0.38	2.72
84	-0.04	4.29**	0.79	-1.17**	0.10*	0.80	0.69	7.39**
86	-0.15**	0.73**	-3.26**	0.10	0.06**	0.49	0.22	1.82
89	-0.41**	4.74**	-7.66*	-1.23**	0.24**	0.34	0.01	0.99
SITC Group 9: Commodities Not Classified According to Kind								
95	0.08**	0.16	0.35	-0.06**	-0.04**	0.83	0.73	8.96**

Table 2 (continued)
Tests of Factor Endowments and Product Trade (Disaggregated Data)

(b) β values	Capital	Labor-skilled	Labor-unskilled	Agricultural land	Minerals
SITC Group 0: Food and Live Animals					
00	0.46	-0.41	-0.03	2.14	-2.41
01	-2.26	0.08	-0.24	1.13	1.38
02	-2.29	0.03	-0.25	1.4	0.67
03	1.04	-0.95	-0.2	1.21	-1.57
04	-1.19	-0.68	-0.18	1.87	0.28
05	-0.79	-0.11	0.22	0.83	-0.57
06	-2.25	0.31	-0.2	-0.36	2.39
07	-0.86	-0.53	0.06	0.09	0.28
08	0	0.09	0.01	1.82	-1.09
09	-2.72	0.4	-0.3	0.55	1.76
SITC Group 1: Beverages and Tobacco					
11	0.7	-1.15	1.03	-0.98	0.68
12	-1.13	-0.65	-0.04	0.46	1.71
SITC Group 2: Crude Materials , Inedible (Except Fuels)					
21	0.62	-0.1	-0.02	0.96	-1.03
22	0.47	-1.68	0.19	1.63	-0.82
23	-2.32	0.46	-0.16	0.11	0.95
24	0.23	-1.19	-0.15	2.38	-1.22
25	-2.31	0.32	-0.56	0.82	1.31
26	-0.84	-0.86	-0.04	1.3	0.66
27	0	-1.01	0.34	0.3	0.18
28	-1.56	-0.08	-0.21	1.75	-0.41
29	-0.11	-1.04	0.23	1.32	-0.51
SITC Group 3: Mineral Fuels, Lubricants and Related Materials					
32	3.37	-1.08	0.45	-1.56	-0.53
33	0.57	-1.12	0.11	1.03	0. 2
SITC Group 4: Animal and Vegetable Oils and Fats					
41	-0.28	-0.33	-0.19	2.26	-1.57
42	-3.02	0.89	-0. 1	-0.59	2.74
43	-2.35	0.19	-0.23	0.55	1.18
SITC Group 5: Chemicals					
51+52+53+55+59	0.43	0.71	-0.03	-2.06	0.49
54+56+57+58	0.55	-0.06	0.11	-1.54	1.38
SITC Group 6: Manufactured Goods, Classified Chiefly by Material					
61	-2.81	1.34	-0.46	-0.47	2.52
62	-1.09	1.53	-0.15	-1.22	1.38
63	-3.04	0. 6	-0.35	0.27	2.09
64	-1.62	0.67	-0.24	-1.06	2.45
65	1.73	0.65	0.17	-1.01	-1.43
66	-0.52	0. 5	-0.52	-1.34	1.29
67	1.36	0.12	0.33	-2.16	1.04
68	-0. 6	-1.27	0.08	1.33	0.66
69	0.58	0.26	0. 1	-1.91	1.59
SITC Group 7: Machinery and Transport Equipment					
71	1.75	-0.48	0.16	-1.1	0.53
72	0.56	0.17	0.04	-1.87	1. 7
73	1. 1	0.82	-0.01	-0.78	-0.42
SITC Group 8: Miscellaneous Manufactured Articles					
81+83+85	1.2	-0.07	0.18	-1.54	0.99
82	1.26	-0.2	0.45	-1.11	0
84	-0.18	1.54	0.05	-1.85	0.68
86	-2.09	0.82	-0.62	0.49	1.26
89	-0.87	0.81	-0.23	-0.92	0.77
SITC Group 9: Commodities Not Classified According to Kind					
95	1.93	0.31	0.12	-0.51	-1.46

Notes: t-ratios not reported. (***) denotes significant at the 1% level. (**) denotes significant at the 5% level. (*) denotes significant at the 10% level.
Source: Estevadeordal (1997)

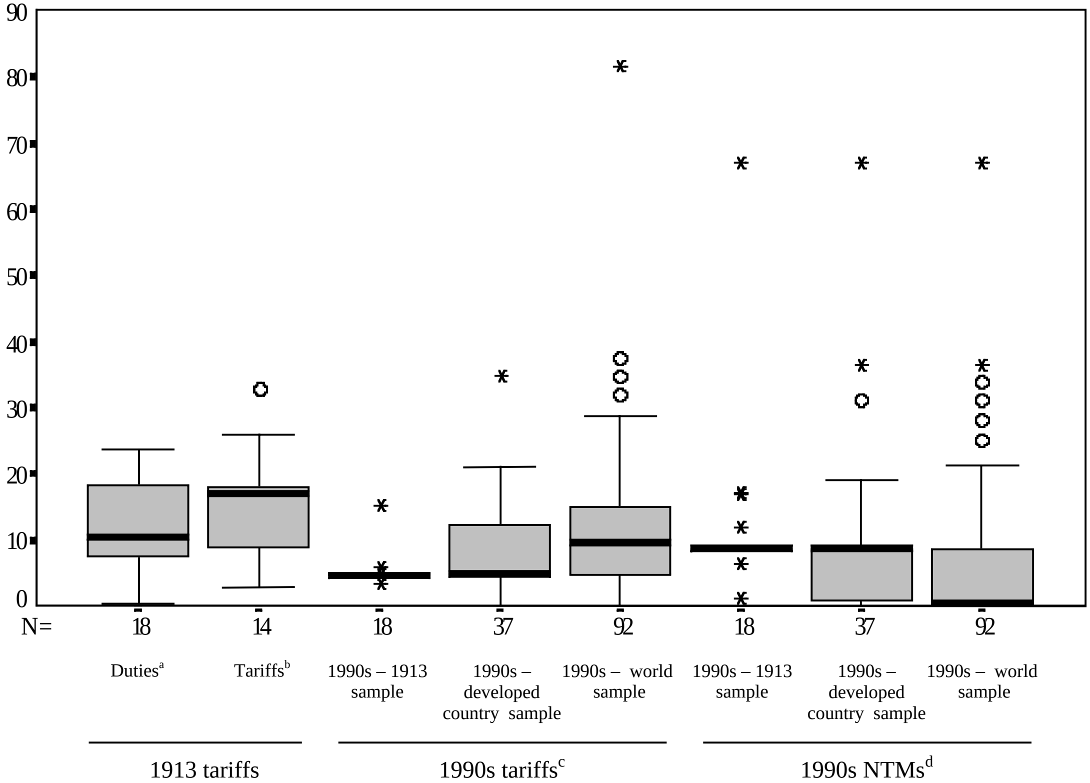
Table 3
Tests of Measured versus Predicted Factor Content of Trade

Factors in the sample		sign	t	VR	slope
		Productivity correction: None			
K	Capital	0.50	1.4	0.01	0.03
L	Labor	0.44	-1.1	0.00	-0.02
Rr	Resources-Renewable	0.67	2.6	—	—
Rn	Resources-Nonrenewable	0.78	2.4	0.38	0.35
K, L, Rn	Pooled	0.57	2.7	0.21	0.17
		Productivity correction: GDP per capita			
K	Capital	0.72	2.4	0.01	0.06
L	Labor	0.44	0.2	0.18	0.02
Rr	Resources-Renewable	0.83	3.0	—	—
Rn	Resources-Nonrenewable	0.78	3.6	0.51	0.52
K, L, Rn	Pooled	0.65	4.9	0.39	0.37

Notes: See text; sign = sign test; t = t test; VR = variance ratio test; slope = slope test.
Source: Estevadeordal and Taylor (2002).

Figure 1
Tariffs and Non-Tariff Indices
1913 and Mid-1990s

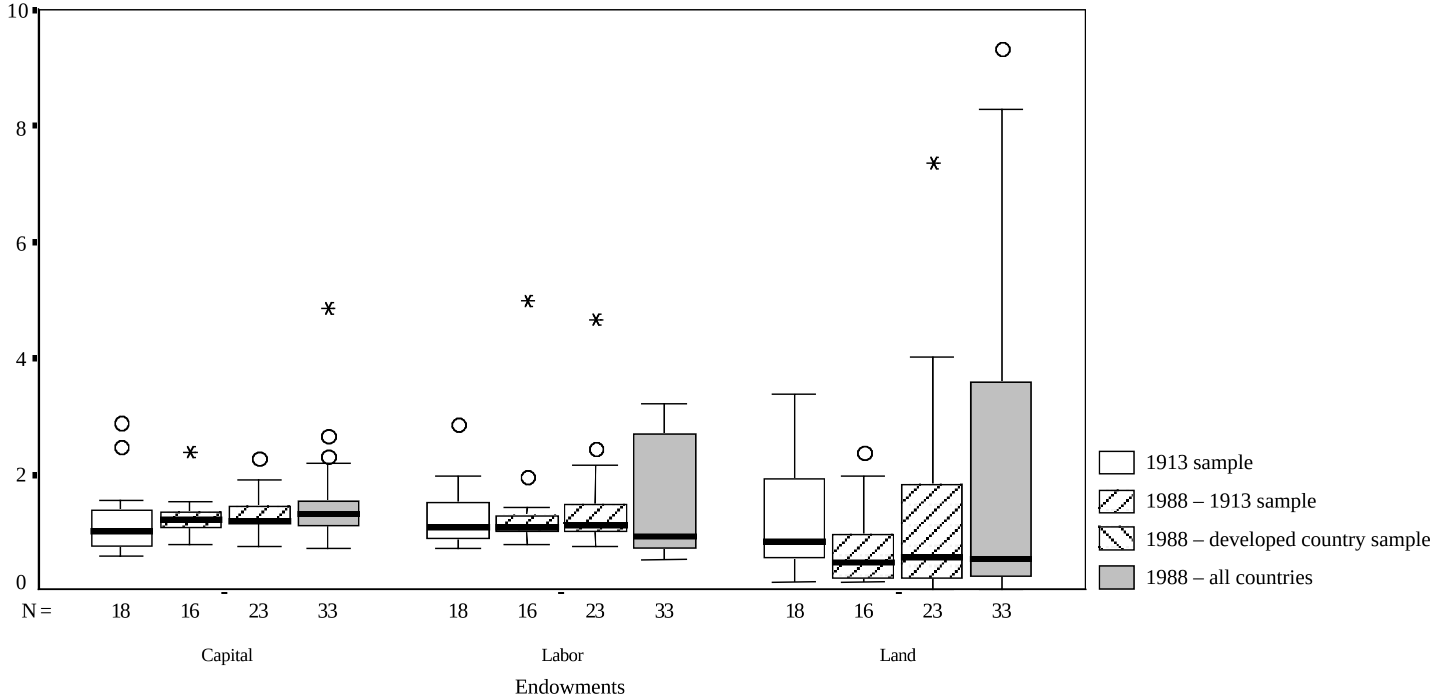
Percentages



Notes and Sources: (a) Duties as a percentage of total imports as reported in Estevadeordal (1997).
(b) League of Nations tariff level indices as reported in Estevadeordal (1997).
(c) Total charges from UNCTAD/TRAINS Database.
(d) Non-tariff incidence measure from UNCTAD/TRAINS Database.

Figure 2
Relative Shares of Endowments
1913 and 1988

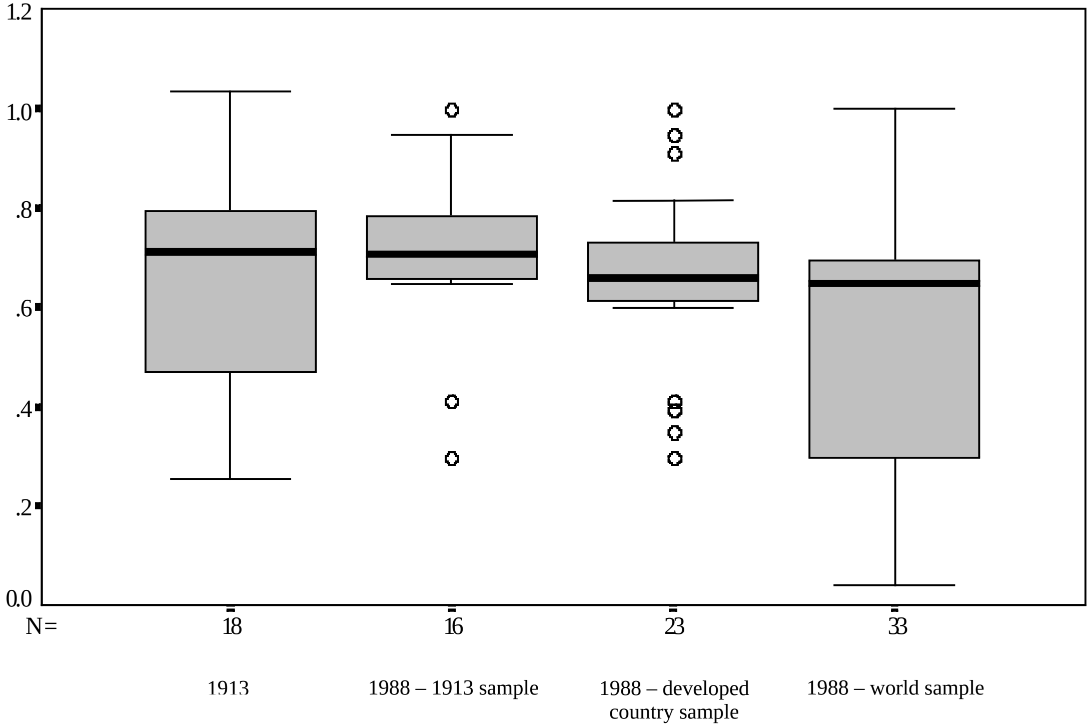
Measured as $(V_{fi}/V_{fw}) / (Y_i/Y_w)$



Notes: "1988 – 1913 sample" does not include Argentina and Australia.
V_{fi} is country i's endowment of factor f; V_{wi} is the "world" endowment of factor f;
Y_i is country i's GNP; Y_w is "world" GNP. "World" is defined by the sample size.
Sources: 1913 data come from Estevadeordal (1997), and 1988 data come from Trefler (1995).

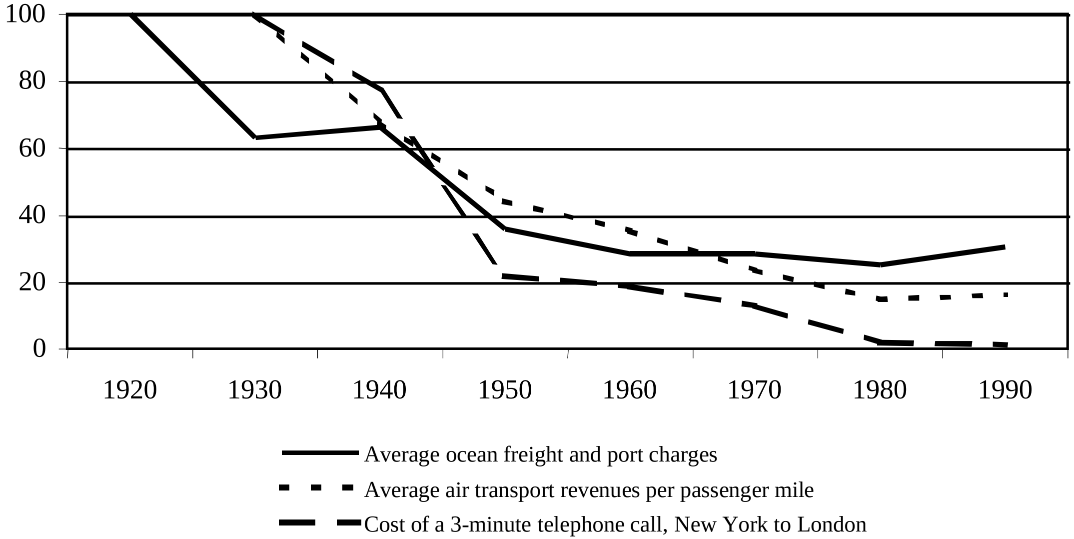
Figure 3
Relative Productivity
1913 and 1988

Measured as real GDP per capita, US=1



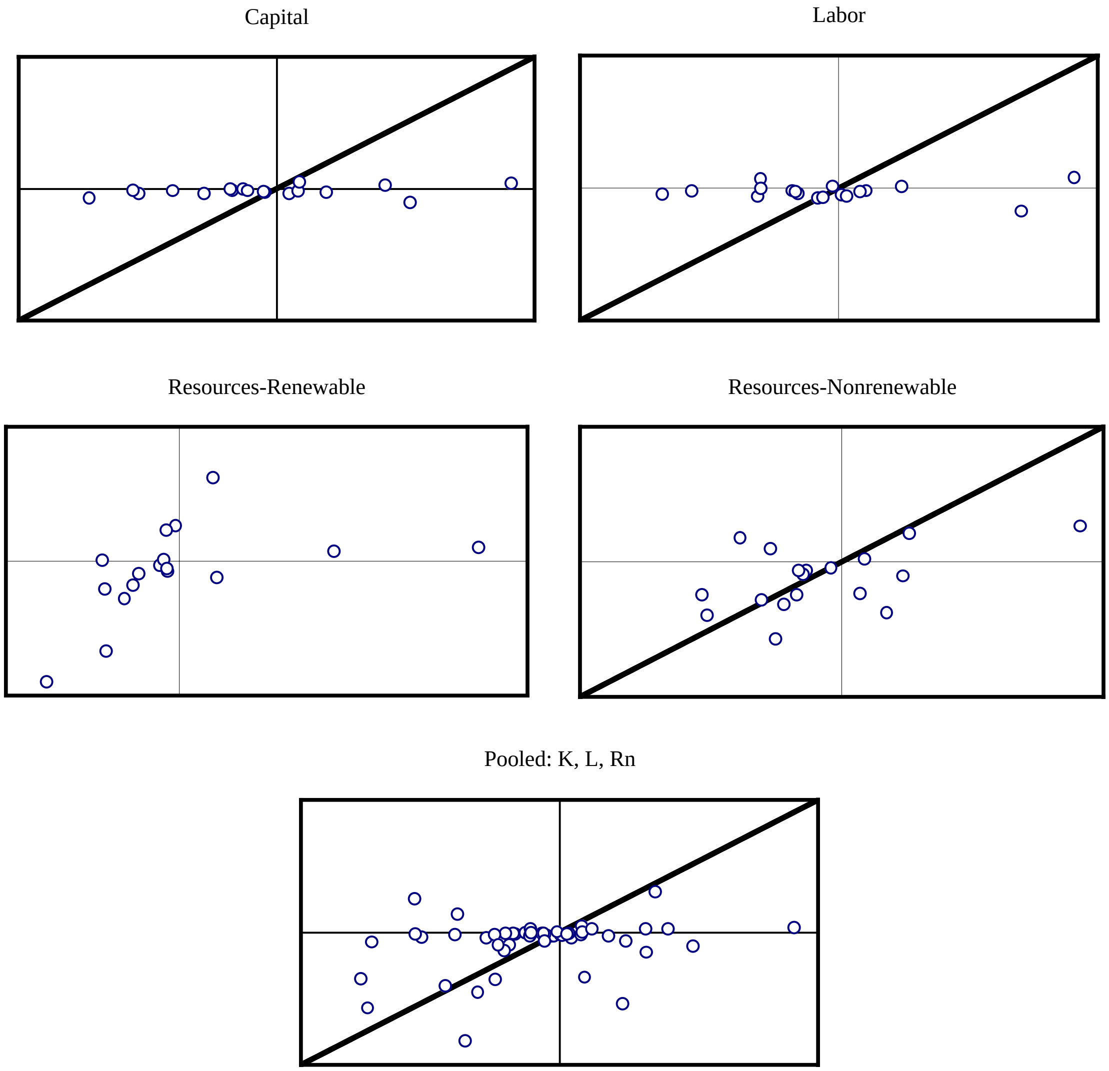
Note: "1988 - 1913 sample" does not include Argentina and Australia.
Sources: 1913 data come from Maddison (1995), and 1988 data come from Trefler (1995).

Figure 4
Transport and Communication Costs
1920 - 1990



Source: Hufbauer (1991).

Figure 5
Measured versus Predicted Factor Content of Trade



Notes: MFCT on vertical axis, PFCT on horizontal. Trefler weights, no productivity correction. See text and Table 2. Units on each axis are non-commensurate for renewable resources, hence 45-degree line is omitted.