EXPLAINING UNITED STATES INTERNATIONAL TRADE 1870-1910

by

William K. Hutchinson

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DEPARTMENT OF ECONOMICS
VANDERBILT UNIVERSITY
NASHVILLE, TN 37235

www.vanderbilt.edu/econ

Explaining United States International Trade, 1870-1910*

William K. Hutchinson
Department of Economics
Vanderbilt University
Nashville, TN 37235
william.hutchinson@vanderbilt.edu

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Abstract

Wright (1990) presents evidence on the factor content of trade that indicates the United States tended to export goods that were raw materials intensive. Using factor per unit of output ratios derived from the United States Census of Manufactures, we are able to supplement Wright's findings for the period 1870 to 1910, a period in which his results were not as conclusive as were his results for later periods. In addition to the female and child labor content of trade during this period, the Census data also allow us to examine a measure of the human capital content of trade during the period 1870 to 1910. Net exports tended to be capital intensive relative to labor and materials. However, a complementary relationship existed between capital and materials relative to labor which resulted in a positive relationship between labor value per unit of output and net exports.

Key Words: International trade; Heckscher-Ohlin; factor proportions; factor content of trade

> *It has often been said that ... the spread of industrialization ... tends to diminish the importance of international trade by reducing those differences in economic structure and skill which are the basis for profitable exchange. The importance of international trade in the nineteenth century was therefore considered to be a temporary phenomenon.*
> Robert Lipsey *(1963: p 36)*

Explaining the pattern and volume of international trade continuously challenges economists to build better models or find better data. The challenge for the economic historian who attempts to explain the pattern and volume of trade for the late nineteenth century United States is no less daunting. Although the volume of United States trade, exports plus imports, during the period 1870 to 1910 increased 3.8 percent per year, we know that as a result of relatively slower export growth, total trade declined from 14 percent to 13 percent of gross national product in 1913 prices.

Nearly everyone would agree that international trade occurs because of mutual gains perceived by traders in each country. Determining which products will be traded and the volume of trade are not as well understood. Industries that produce products for export and the products that are imported depend on comparative advantage, which according to the Heckscher-Ohlin model of international trade was determined by relative factor abundance. Trade is presumed to be interindustry in nature, with exports from industries that use more intensively the relatively abundant factor(s). Industries that are intensive in the relatively scarce factor(s) comprise the body of imported products. How does the changing structure of the United States economy compare with the changing pattern of United States international trade during the period 1870 to 1910? In an attempt to answer this question we analyze bilateral trade in 31 products between the United States and seven trading partners at ten year intervals during the period 1870 to 1910. A factor proportions model is estimated using factor input data for these 31 to determine the implied factor content of United States trade.

Changing Trade Patterns

If one groups total trade according to trade in two categories: (1) crude goods (crude materials and crude food); and (2) manufactured goods (manufactured food[1], semi-manufactured goods, and manufactured goods), then the composition of total trade changed only slightly during

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[1]Manufactured food includes food items ready for consumption and food items that require further processing before consumption.

the period 1870 to 1910. Category (1), crude goods, accounted for 46.5 percent of trade and manufactured goods accounted for 53.5 percent in 1870, whereas in 1910 the distribution was 43 percent and 57 percent, respectively. Two separate changes were occurring within the crude goods category. Both crude food exports and crude food imports decreased as a share of total trade during this period. However, the declining importance of raw cotton exports was completely offset by the increase in crude materials imports as a share of total trade. Growth of crude materials imports was due to the growing importance of such imports as raw silk, tin, crude rubber, and hides. All of these were used as inputs for either manufactured or semi-manufactured goods that were fueling the growth of exports. Exports of semi-manufactured goods and manufactured goods increased from 19 percent of total exports to 45 percent of total exports between 1870 and 1910.[2]

Chart 1 illustrates these changes in the relative importance of the two categories for both exports and imports. The United States economy shifted from a deficit trade position in manufactured goods and a surplus in crude goods to a surplus in manufactured goods and a deficit in crude goods between 1870 and 1910.

The pattern of trade reflects structural changes that occurred in the economy during the period 1870 to 1910. In particular, during the 1880s manufacturing output surpassed agricultural output to the extent that by 1890 the value of manufacturing output was three times that of agriculture. (Atack and Passell, 1994: 457) The 1880s were a period of rapid change in United States manufacturing as the optimal size firm increased significantly for many manufacturing industries and capital investment more than doubled the capital-labor ratio in manufacturing between 1870 and 1890; over 70 percent of this increase came in the 1880s. These substantial changes in the factor proportions in manufacturing are nearly matched by the 170 percent increase in the capital-labor ratio in agriculture during the same period. Exports originating in the agricultural sector were increasingly in the form of manufactured food goods.

Wright (1990) presents evidence on the factor content of trade for part of the period considered in this article. His results indicate that higher capital labor ratios were associated with greater net exports, although his results indicate this effect diminishes over time. Wright's general argument for the natural resource/materials content of trade is supported by his data only

[2]These data are derived from *Historical Statistics of the United States: Colonial Times to 1970* (1975) pp. 889-890.

for the very end of the period 1870 to 1910. Prior to 1910, the coefficient on natural resource/materials inputs was negative but insignificant. We provide evidence below that supplements Wright's results in an attempt to better understand the factor content of trade during the period 1870 to 1910.

The difficulties and pitfalls associated with econometric expressions of factor proportion models are discussed in Section II, the data sources are discussed in Section III, and empirical results are presented in Section IV followed by concluding comments in Section V.

II. MODEL

International exchange of goods and services can be thought of as the international exchange of factor services which are embodied in the goods and services that are actually exchanged. The Heckscher-Ohlin-Vanek model of international trade focuses on the factor content of trade and predicts that a country will export products that embody proportionately more of the factors that are relatively abundant in that country. Analogously, a country will import products that embody proportionately more of the factors that are relatively scarce in that country.

The theoretical specification of the Heckscher-Ohlin-Vanek (HOV) model places very restrictive specifications on empirical implementation of the model. The model specification implies that one should regress net exports on relative factor endowments to determine the actual factor abundance of a country. However, factor input coefficients for the home country, especially the United States, are more readily available than relative factor endowment data. This prompted many researchers to substitute factor input coefficients for relative factor endowments to determine the factor content of trade and the revealed factor abundance of the home country. Bowen, Leamer, and Sveikauskas (1987) demonstrated that this method of estimating the HOV model very likely violated the theoretical restrictions of the model. Fortunately, Bowen and Sveikauskas (1992) demonstrated that, in most cases, the possible violations of the theoretical specification of the HOV model were not sufficiently important as to nullify the results obtained by regressing net exports on factor input coefficients.

Due to the lack of input-output tables for a lage number of countries, one usually uses the input-output data for the home country to estimate the factor content of trade with all countries. Trefler (1995) raised questions about this procedure as well in his investigations into the mystery

of the "missing trade." Issues related to the missing trade continue to be discussed in the trade literature.[3]

We shall use the typical methodology to empirically investigate the factor content of trade by invoking the findings of Bowen and Sviekauskas (1992) as support for this approach. Equation (1) contains the estimating equation that we employ. This model is based on the derivation in Bowen and Sviekauskas (1992).[4] T_{ikt} is a measure of net exports of good i from the United States to country k in year t. K_{it}, L_{it}, and MAT_{it} represent the capital stock, labor and materials, respectively, used per unit of output of the good i in the United States in year t. ε_{ikt} is a random error term.

(1) $$T_{ikt} = \beta_0 + \beta_1 K_{it} + \beta_2 L_{it} + \beta_3 MAT_{it} + \varepsilon_{ikt}$$

This model is very similar to that used by Wright (1990) where he was particularly interested in the factor content of trade for the purpose of identifying the natural resource/materials content of trade.[5] Results from estimating equation (1) will be very comparable to those found by Wright and will serve to supplement those findings by providing evidence for additional years and additional factor specifications. That is, we disaggregate the labor input data to consider female, child, and salaried workers separately from adult male laborers. Data for salaried workers, available only for 1900 and 1910, allow us to consider skilled (higher human capital) labor as a factor input.

III DATA

The model represented in equation (1) is estimated using data from a variety of sources for the period 1870 to 1910. The wholesale price indexes are from Warren and Pearson (1933) and average tariff rates are from *Historical Statistics of the United States from Colonial Times to 1970* (1975). The import and export price indexes are from Williamson (1964). Bilateral data

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[3]See Donald R. Davis and David E. Weinstein "The Factor Content of Trade" forthcoming in James Harrigan (ed.) *The Handbook of International Economics* Blackwell Publishers for an excellent discussion of the issues surrounding empirical investigations of the factor content of trade.

[4]An appendix to this paper which contains a theoretical derivation of equation (1) from the Bowen and Sviekauskas (1992) paper is available from the author.

[5]Wright (1990) used input coefficients for 1879 and 1899 from Eysenbach (1976) and calculated his own for 1909. Others have used input coefficients as well. (cf. Leontief (1953) for the United States and Crafts and Thomas (1985) who use factor intensities for Great Britain to explain the factor content of British trade.

for exports and imports are from *Commerce and Navigation Reports* for the census years from 1870 to 1910. All data are valued in 1913 prices.

Data for factor intensities are taken from the *U.S. Census of Manufacturers* for the years 1870, 1880, 1890, 1900, and 1910. It is the availability of industry data for export and import commodities that limits the number of industries considered to 31. These 31 industries account for 35 percent of total trade on average[6] and trade with these 7 countries accounts for 65 percent of total trade. Moreover, trade in these 31 industries averages 33 percent of total trade with these 7 countries after 1870. Thus, results from estimations using data relating to trade in these 31 industries with these 7 countries should provide insights into the proximate causes of bilateral trade during this period.

IV. EMPIRICAL RESULTS

Before attempting to estimate the model it may be useful to examine some characteristics of the export and import industries included in the 31 industry sample. On average, approximately two-thirds of the industries are both export and import industries. Thus, inclusion of refined sugar, which was both an export and an import, does not affect the relative capital intensity of export and import industries.[7] The ratios of the capital labor ratio of exports to the capital labor ratio of imports in Table 1.b are very similar to those in Wright (1990).

The data in this paper reflect the ratio of real capital, labor, and materials in a particular industry to the real output of that industry.[8] These are not technical input-output coefficients. These data indicate that real capital per unit of real output increased for export and import competing industries during the period 1870 to 1910, whereas labor per unit of output decreased for both. Not surprisingly, the data in Table 1.b indicate that the capital-labor ratios for export and import competing industries also increased. The capital-labor ratio for both the export and

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[6]These 31 industries accounted for more than 70 percent of the trade in manufactured goods or group (2) above.

[7]Wright (1990) leaves refined sugar out citing its high capital intensity. Estimations were done with and without refined sugar and the results were little different qualitatively. Reported results are from regressions with sugar omitted in order to make our results more comparable to Wright's.

[8]The data in Table 1 are not trade weighted. They are unweighted averages for the 31 manufacturing industries including sugar. Results for Table 1 omitting sugar are little different from those reported. Both the capital and the labor per unit of output are higher without sugar which results in ratios of the export to import capital-labor ratios that are very similar to those reported in Table 1. .

import industries exceeded the average capital-labor ratio for total manufacturing in each year. However, the average capital-labor ratio for manufacturing increased more rapidly than it did for these export and import industries in Table 1. The last row of Table 1.b indicates that, the capital-labor ratio for export industries increased slightly relative to the capital-labor ratio for import competing industries, from 1.098 in 1870 to 1.116 in 1910, although it peaked in 1890 at 1.241. This pattern is consistent with evidence found by James (1983) regarding capital investment in manufacturing. However, these results are counter to those found in Wright (1990) where capital labor ratios declined in export industries and increased in import industries.[9]

Rising relative capital-labor ratios in import competing industries are consistent with the fact that imports of these 31 industry products decline as a percentage of total imports during this period. Imports of nonmanufactured goods became a larger share of total imports which explains how total imports could increase as a percentage of GNP after 1900 in light of the declining importance of these 31 manufacturing industries as well as imports of manufactures in general.

Other measures for comparing export industries with import competing industries are the extent to which these industries employed women and children as well as the employment of salaried employees. One may argue that salaried workers (not proprietors) possessed higher human capital/skill levels. Data for salaried workers are available only in the censuses for 1900 and 1910, but the evidence in Table 1.c indicates that the use of salaried workers was increasing relative to output after 1900 in both export and import competing industries. The use of salaried workers per dollar of output appears to have been 11.7 percent higher in the export industries in 1900 and 13.6 percent higher in 1910 than it was in the import competing industries. Thus, although the capital-labor ratio appears to have been rising in import competing industries relative to export industries during the period 1900 to 1910 (Table 1.b), the level of human capital, as measured by salaried employees, per dollar of output appears to have been increasing in the export industries relative to the import industries. The human capital evidence for export industries is consistent with the work of Crafts and Thomas (1985).

The data in Table 1.c indicate that the employment of women in export industries declined between 1870 and 1880, but increased thereafter until 1910, when it was 46.3 percent

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[9]Although the increase is rather significant for exports, it may be due in part, at least, to the selection of industries comprising exports in this paper as compared to the sample used by Wright (1990).

higher than in 1870. On the other hand, despite an increase between 1900 and 1910, the use of women in import competing industries declined by 16.2 percent during the period. Both export and import competing industries experienced relatively large increases in the employment of women per dollar of output between 1900 and 1910, 71.4 and 81.5 percent, respectively.[10] This evidence is consistent with other evidence regarding employment patterns for women during this period. (Atack and Passell, 1994:533)

The employment of children per unit of output in both export and import industries declined during the period 1870 to 1910, but it was always lower for export industries than for import competing industries. Despite the fact that import competing industries employed approximately fifty percent more children per dollar of output in 1910 than export industries, this was much more comparable than the 300 percent higher ratio for children in import industries relative to children in export industries in 1870. The previous discussion, regarding the relative rise in the capital-labor ratio in import competing industries along with the increased use of salaried workers in import competing industries, is consistent with the argument that it was rising productivity in import competing industries that resulted in imports of manufactured goods declining by a third as a proportion of total imports during this period. The decline in imports was coincidental with an approximate fifty percent decline in the average tariff rate, when measured relative to all imports.[11]

The preceding background information regarding the export and import competing industries will enhance the discussion of the empirical results on the relationship between factor inputs and trade. Exports of manufactures nearly double as a share of total exports while imports of manufactures as a share of total imports decline by 28 percent.

Factor Proportions Results

Estimation of equation (1) as a double logarithmic Tobit regression form for all industries in the five observation years. Using factor-output ratios as measures of input coefficients, allows one to determine the relative roles of these factors in trade for this set of 30 industries with seven

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[10]Although the ratio of female labor to output declined between 1890 and 1900, which accentuates the increase to 1910, the increase in female labor per unit of output between 1890 and 1910 was 16.67 percent.

[11]This is based on calculations from the average tariff data in *Historical Statistics of the United States from Colonial Times to 1970* (1975) p. 888.

trading partners.[12] Tobit regressions were used due to the prevalence of zero values for the dependent variable, net exports. Following Eichengreen and Irwin (1995), we first add one to all export and import values before taking logarithms. Net exports are represented as log(exports) minus log(imports) for each commodity. All right-hand-side variables are expressed as logarithms, which results in coefficients that are elasticities. Results presented in this paper may differ from those found by Wright (1990) because we look at trade with only seven countries for 30 industries, whereas it appears that Wright looked at total net exports for an industry and examined a larger number of industries. Examination of bilateral trade with specific countries that accounted for a large portion of total United States trade allows us to control for country specific characteristics.

Following Leamer (1980), the model is estimated for net exports and these results are in Table 2.a. Capital per dollar of output has a significant positive effect on net exports in these 31 industries whereas labor and materials used per dollar of output have significant negative effects on net exports. These relationships are consistent with Crafts and Thomas (1986) who, using data for 1909, argue that the United States exported goods that were physical and human capital intensive and imported goods that were labor intensive.[13] If materials used per dollar of output may be interpreted as a proxy for natural resource inputs, then the significant negative effect for materials on net exports informs us about the results Wright (1990) found for this period.[14]

Table 2.b contains estimates of the value of net exports as a function of the average amount of capital and labor per firm in each industry. These results may reflect scale effects that were present. Larger average amounts of capital per firm are associated with larger net exports in an industry. The opposite is true for labor, industries with firms that have larger average amounts of labor tend to have lower net exports. If one judges scale by the amount of capital per

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[12]All trade regressions were run both with and without sugar. However, to facilitate comparison with Wright (1990) only the results from regressions without sugar are reported in the paper. The results of regressions with sugar are qualitatively similar and are available from the author.
[13]At that time Britain was found to have exported labor intensive goods and imported goods that were production intensive either in physical or human capital.
[14]Wright's (1990) results for the period prior to 1910 indicate a negative relationship between his "natural resource coefficient" and net exports. His positive relationship between natural resource content and net exports first appears in 1910 but is not significant. We examine year-by-year results below.

firm, then these results are consistent with arguments that comparative advantage for the United States was in large scale industries.

Labor Sub-groups

Assuming that labor is homogeneous tends to raise questions regarding the model's approximation of reality. The results presented in column 1 of Table 3 allow one to assess the effects of different types of labor on net exports. As in Table 2, the results indicate that capital has a positive effect for net exports. Controlling for total labor per unit of output, disaggregation of labor into three categories: Female labor; Child labor; and Salaried labor per unit of output, provides a greater understanding of the relationship between factor-output ratios and trade. Labor per unit of output accounts for the total labor per unit of output, whereas female and child labor per unit of output allow us to determine the marginal impact of these two types of labor. Net exports are significantly negatively affected by all types of labor per dollar of output, which is consistent with the results from Table 2. Net exports are positively related to the amount of capital per dollar of output as was the case in Table 2.[15]

Data for salaried workers per dollar of output, which may be used as a proxy for human capital, are available only in 1900 and 1910. Results from a net export regression that included salaried workers per unit of output appear in column 2 of Table 3. All the coefficients are larger and significant for the 1900 to 1910 period with salaried workers as a separate labor category. The coefficient for salaried workers is both large and significant. That is, an industry in which salaried workers per dollar of output is ten percent above the mean would be expected to have net exports that were 21.3 percent above the mean value of net exports for 1900 to 1910. The coefficient on child labor becomes positive and significant when salaried workers are entered separately. Thus, in 1900 to 1910, net exports were greater in industries that had higher child labor per dollar of output, when one accounts for salaried workers. Thus, the evidence in Table 3 would lead one to believe that the United States appears to have had a comparative advantage in industries that had higher capital and salaried workers (human capital) per dollar of output. On the other hand, the United States had a comparative disadvantage in industries that employed above average amounts of adult labor, other than salaried labor, per unit of output. The results for salaried workers support the conclusions of Crafts and Thomas (1986) who also found that

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[15]The results for women and child labor are consistent with those found by Wright (1990).

net exports of the United States were production intensive in physical capital and human capital.[16]

Materials input per dollar of output has a negative effect on net exports, especially in 1900 and 1910 when salaried workers are included separately. It would appear that accounting for salaried workers separately enhances the effect of capital per dollar of output and accentuates the effect of materials in explaining net exports. Net exporters tended to be industries with more capital per dollar of output, but especially industries that employed more salaried workers per dollar of output. These same industries also tended to be ones that used less materials per unit of output.

Additional Considerations

Many issues arise when one analyzes pooled time series data in a study, but two particular issues will be dealt with in this section: how do the model coefficients behave over the time period and was the trade relationship the same between the United States and each of the seven countries? The results in Tables 2 and 3 all controlled for time and country fixed effects. Thus, we shall consider how our previous results may have changed during the period 1870 to 1910. We shall also examine the bilateral relationships with each of the seven trading partners. One can only speculate at this point regarding different ways in which each country's trade relationship with the United States may have changed during this period. We consider the time issue first and then the individual country issue.

Changes Over Time

Table 4 contains the results from estimating the factor proportions model with disaggregated labor for each of the census years from 1870 to 1910 and with salaried labor for 1900 to 1910. The results for 1870 indicate that this year was different than the other four, because the coefficients on capital and labor have signs that are the opposite of those obtained in any other year or for all sample years in the aggregate. The year 1870 was one in which the factor content of net exports was apparently positively affected by all labor except child labor, whereas capital had a negative effect on net exports. The implied net exports in 1870 were 33.7 percent below the mean for industries that had child labor per dollar of output that was ten

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[16]If one omits salaried workers from the 1900 and 1910 regression, then the coefficients on capital and labor per unit of output are larger and of the same sign as in Table 3. However, the female and child labor are both negative and insignificant when salaried workers are omitted.

percent above the mean. Thus, industries that had relatively high child labor input had relatively low net exports. The same was true for capital. It was industries that employed adult labor that accounted for net exports in 1870.[17]

In 1880 and after, child labor had no effect on net exports, capital had a positive and significant effect on net exports, and adult labor had a negative and significant effect on net exports. If one ignores 1870, one might conjecture that net exports became relatively more capital intensive while the labor intensity did not change much. The use of female labor had a significant negative effect on net exports in 1880 and 1890 but no effect in any other year. Thus, net export industries were those with lower female and child labor per dollar of output. As in Table 1.c, import industries tended to use more female and child labor in 1910.

An examination of the results for various types of labor in Table 4 might lead one to argue that United States net exports first improve in industries that used relatively less child labor (1870), then improved for industries that used relatively less female labor (1880-1890) and finally net exports improved for industries that used less labor in general (1880-1910). Capital per dollar of output had an increasingly positive effect on net exports after 1870.

Taking yet another look at the data in Table 4, one can see that the coefficients on capital, labor and materials all increase significantly between 1880 and 1890. One may conjecture that such a shift indicates a dramatic change in domestic export manufacturing that did not benefit female and child labor. That is, the new industrial structure was such that only the productivity of non-child and non-female workers was significantly affected. Materials per dollar of output was increasingly negatively associated with net exports during the period. The results for both 1890 and 1910 are significant and negative which are inconsistent with results in Wright (1990: 659) Existence of a dramatic shift in manufacturing between 1880 and 1890 was also noted in the opening discussion.

Regression results for 1900 and 1910, when data for salaried employees are first available, appear in the last two columns of Table 4. In 1900, the separation of salaried labor reduces the significance of capital per dollar of output, but the coefficient remains large and positive indicating a lack of precision in estimation. The 1910 results indicate that capital per

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[17]It is worth noting that average capital per firm was positively related to net exports and average labor per firm was negatively related to net exports in 1870 as well as the other years. (Results available from the author on request.)

dollar of output is a significant factor in net exports, but salaried employees are insignificant. However, both capital and salaried workers have positive coefficients. Labor inputs have the same effect on net exports as when salaried workers were not accounted for separately. Crafts and Thomas (1986) found that their measure of human capital had a small but significant effect on net exports in 1909. Thus, two separate types of human capital measures indicate that human capital was an important factor in net exports for the United States.

By Country Results

All of the previous regressions have controlled for country fixed effects in an attempt to control for those characteristics that determine trade, but which are specific to a given country. Table 5 contains results from estimating the factor proportions model for each of the seven countries in the sample. The coefficients have the same signs as in the pooled regressions but the degree of significance varies considerably from country to country, reflecting the lack of precision in estimation.

Capital per dollar of output has a positive effect on net exports for all countries but is significant only for Belgium, France, Italy, and the Netherlands. Labor per dollar of output, on the other hand, is negative for all countries and significant for Belgium, Germany, Italy and the Netherlands. Belgium, Italy and the Netherlands are the only ones for which both capital and labor per unit of output are significant. For all of the countries, but especially for these three, United States net exports were greater for industries in which the capital per unit of output was higher and the labor per unit of output was lower. The implication is that the United States was relatively capital abundant and labor scarce in comparison with these seven countries. Crafts and Thomas (1986) found that net exports for the United Kingdom indicated that it had a relative abundance of unskilled labor, which is totally consistent with the results in Table 5 for the United Kingdom. The capital stock grew at a higher rate relative to population in the United States than it did on average in these counties, which would accentuate the relative capital abundance of the United States. (Hutchinson, 1991)

Materials (resources) per dollar of output are negative for all countries but significant for Belgium, Canada, and Germany, indicating that the United States tended to import goods from these countries that were relatively more materials intensive, on a net basis. Examples of this would be wood from Canada, cheese from Belgium, and silk manufactures from Germany.

Female labor had a negative effect for net exports to all seven countries and it was significant for France, Netherlands, and Italy. This indicates that the United States tended to import relatively more goods in industries that employed women than it exported to these countries. Industries in which child labor was used in the United States tended to have significantly lower net exports in the case of Germany and the United Kingdom. The effect of child labor was negative for all countries as was true for female labor.

Although, the comparative advantage for the United States differed somewhat from country to country. However, in all cases the data indicate that comparative advantage was in industries that were neither labor nor materials intensive. This bilateral evidence is consistent with the pooled data results and indicates that the United States was revealed to have had a comparative advantage in capital intensive goods.

Complementarities

Wright (1990) attempts to assess the possibility of a complementary relationship between capital and materials by estimating an equation in which capital per unit of output is interacted with materials per unit of output relative to labor per unit of output. He included the percentage of the labor in each industry that were female or child labor as well as the wage. We estimate a similar equation where the wage variable is the average industry wage times the labor per unit of output. The results are reported in Table 6 for all years and by year.[18]

Data for all years indicate that capital and materials per unit of labor has a large but not significant effect on net exports, but net exports are less for industries with a high proportion of female and child labor as well as high labor value per unit of output. The apparent complementarity between capital and materials is not present in the results for 1870, where the negative relationship between net exports and capital and the positive relationship for labor observed in Table 4 results in a noncomplementary relationship between capital and materials per unit of labor. The results for capital and materials per unit of labor combined with the negative effect of labor value, all on a per unit of output basis, are mutually consistent.

However, for the years after 1870, capital and materials per unit of labor has a significant complementary relationship with net exports. A strong negative relationship exists in all years between net exports and the percentage of the labor in an industry that is female or child labor.

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[18]This equation was also estimated for each country but the results did not differ from those in Table 5. Thus, these results are not reported, but are available from the author.

Although in 1870 the value of labor per unit of output has a negative effect on net exports, it is basically zero in 1880 and significantly positive thereafter. That is, net exports tend to be greater for high value added industries that have more capital and materials per unit of labor. If one equates high value added with higher productivity or higher human capital as measured by Crafts and Thomas (1986), then the United States is revealed to have been abundant in capital, which was complementary with materials, and human capital relative to labor.[19] Industries that were generating net exports were definitely not those with high proportions of women and children in that industry's labor force.

Conclusion

The proximate causes of international trade during the period 1870 to 1910 appear to have been the relative use of capital, highly productive labor and materials per dollar of output. Net exports were greater in industries where more capital was employed per dollar of output which was found to be complementary with materials used per unit of output. Moreover, in the years where data are available for salaried employees, 1900-1910, industries with larger numbers of salaried employees per dollar of output (greater human capital) were observed to have larger net exports.

To the extent that materials inputs are a proxy for natural resource inputs, the results in this paper run counter to the general argument in Wright (1990) when considered as a separate input. Wright also found a negative but insignificant relationship between his natural resource input coefficient and net exports of manufactures for 1879 and 1899. (See Table 4 in Wright (1990, p. 659.) It appears that during the period 1870 to 1910 net exports of these 30 industries tended to be greater when the materials ("natural resources") per dollar of output were lower.

Evidence in Table 4 indicates that the importance of capital as a factor input for net exports increased during this period, whereas labor inputs were observed to have an increasingly negative effect on net exports. A major finding is the significant complementarity between capital and materials for net exports that over shadows the negative relationship between materials per unit of output and net exports. The high value added for net export industries

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[19]Margo (2000) and Goldin (2001) have found that returns to education were rising throughout the nineteenth century. It would appear from the results in Tables 4 and 6 that United States net exports reflected the expansion of industry into capital intensive, resource using industries that employed more highly educated workers, i.e., high value workers.

supports the results found for 1909 by Crafts and Thomas (1986). The United States was relatively abundant in capital which complemented its materials endowment to produce high value added goods for export.

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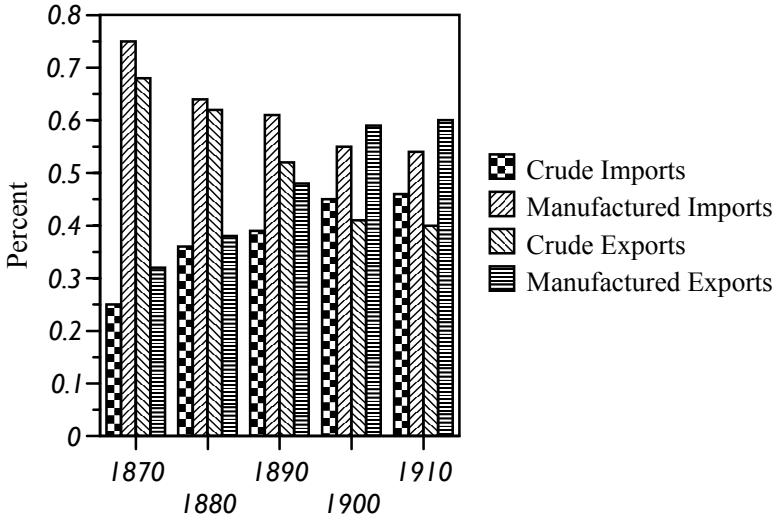
Chart 1: Export and Import Shares, 1870-1910



Source: Historical Statistics of the U.S. Colonial Times to 1970

Table 1.A Factor-Real Output Ratios for Exports and Imports, 1870-1910
(1913 dollars)

	1870	1880	1890	1900	1910
Exports:					
Capital	0.4537	0.4323	0.5691	0.6291	0.7300
Labor	0.00025	0.00018	0.00016	0.00013	0.00017
Imports:					
Capital	0.5020	0.4539	0.5195	0.6272	0.6997
Labor	0.00030	0.00024	0.00018	0.00015	0.0008

Table 1.B Capital-Labor Ratios (K/L) for Export and Import Industries, 1870-1910
(1913 dollars)

	1870	1880	1890	1900	1910
Exports:					
K/L	1806.2	2415.3	3584.6	4662.5	4360.7
Imports:					
K/L	1644.7	1886.2	2888.2	4198.1	3906.1
Ratio Export/Imports:					
	1.098	1.281	1.241	1.111	1.116

Table 1.C Women, Children and Salaried Employees Per Unit of Real Output
(All numbers below are multiplied by 1,000)
(1913 dollars)

	1870	1880	1890	1900	1910
			Exports		
Women	0.0041	0.0017	0.0032	0.0035	0.0060
Children	0.0065	0.0049	0.0031	0.0021	0.0014
Salaried	NA	NA	NA	0.0067	0.0117
			Imports		
Women	0.0117	0.0085	0.0084	0.0054	0.0098
Children	0.0197	0.0111	0.0041	0.0029	0.0021
Salaried	NA	NA	NA	0.0060	0.0103

All data in Table 1.a, 1.b and 1.c are derived from the *U.S.Census of Manufactures* data for 31 manufacturing industries in the years 1870, 1880, 1890, 1900, and 1910.

Table 2.a

Factor Proportions (Intensity) Estimates for Net Exports
(No sugar)

Constant	Capital/Output	Labor/Output	Material/Output	Trend
-46.02***	3.92***	-5.89***	-3.72***	-0.35*
(158.20)	(56.74)	(168.89)	(45.03)	(2.90)

N=1007/93

Table 2.b

Scale Effects for Factor Proportions Estimates for Net Exports
(No Sugar)

Constant	Capital/Firm	Labor/Firm	Trend
-30.60***	4.68***	-5.56***	-0.15
(86.79)	(120.21)	(143.99)	(0.49)

N=1007/93

All estimates are SAS LifeReg Tobit estimates with country fixed effects. Chi-Square statistics are in parentheses. *, **, and *** indicate significance at the 10, 5 and 1 percent level respectively. N=number of observations: total/left censored.

Table 3 Estimates for Net Exports, With Disaggregated Labor, 1870 to 1910 (No Sugar)

Variable	Volume Net Exports	Volume Net Exports 1900-1910)
Constant	-35.36***	-34.35***
	(81.20)	(14.19)
Capital/Output	2.43***	3.62***
	(19.20)	(13.72)
Labor/Output	-2.91***	-6.50***
	(20.88)	(46.30)
Female Labor/ Output	-0.49***	-1.44***
	(13.84)	(16.36)
Child Labor/ Output	-0.65***	1.39***
	(9.39)	(7.89)
Salaried Labor/ Output		2.13***
		(19.30)
Materials/Output	-2.43***	-3.54***
	(15.13)	(14.93)
Trend	-0.13	1.54**
	(0.32)	(3.94)
N	1007/93	420/28

All estimates are SAS LifeReg Tobit estimates with country fixed effects. Chi-Square statistics are in parentheses. *, **, and *** indicate significance at the 10, 5 and 1 percent level respectively. N=number of observations: total/left censored. N=number of observations: total/left censored.

Table 4 By Year Regression Results for Net Exports (No Sugar)

Variable	All Years	1870	1880	1890	1900	1910	1900(a)	1910(a)
Constant	-35.36***	-2.12	-23.79*	-58.74***	-49.41***	-48.19***	-16.08	-33.42**
	(81.20)	(0.05)	(3.74)	(30.88)	(11.83)	(28.88)	(1.03)	(6.23)
Capital	2.43***	-2.63*	2.56**	3.65***	4.11***	5.44***	2.21	4.61***
	(19.20)	(3.39)	(3.96)	(12.71)	(8.46)	(16.39)	(2.37)	(10.14)
Labor	-2.91***	4.66***	-1.89	-6.25***	-4.89**	-5.73***	-5.66***	-6.58***
	(20.88)	(8.53)	(0.99)	(18.26)	(5.87)	(19.37)	(8.46)	(21.59)
Materials	-2.43***	-0.55	2.82	-5.41***	-2.54	-4.08***	-4.27*	-3.53***
	(15.13)	(0.25)	(1.92)	(7.54)	(1.12)	(13.28)	(3.36)	(9.05)
Female Labor	-0.49***	0.10	-1.13***	-0.69**	-0.43	-0.35	-1.87***	-0.87
	(13.84)	(0.12)	(17.04)	(4.65)	(1.34)	(0.30)	(14.56)	(1.45)
Child Labor	-0.65***	-3.37***	-0.01	0.17	-0.38	0.06	1.62**	0.83
	(9.39)	(50.45)	(0.01)	(0.08)	(0.71)	(0.01)	(6.55)	(0.79)
Salaried Labor							2.83***	0.87
							(18.54)	(1.45)
Trend	-0.13							
	(0.32)							
N	1007/93	189/38	196/15	202/12	210/18	210/10	210/18	210/10

All estimates are SAS LifeReg Tobit estimates with country fixed effects. Chi-Square statistics are in parentheses. *, **, and *** indicate significance at the 10, 5 and 1 percent level respectively. N= number of observation: total/left censored.

Table 5 Regression Results for Net Exports: By Country for All Years (No Sugar)

Variable	Belgium	Canada	France	Germany	Italy	Netherlands	United Kingdom
Constant	-49.65***	-22.75***	-31.88***	-41.94***	-37.15***	-43.85***	-29.39**
	(23.17)	(6.71)	(9.78)	(16.02)	(16.39)	(20.84)	(5.99)
Capital	2.80*	1.68	2.62*	1.18	3.81***	2.95**	1.95
	(3.82)	(1.79)	(3.20)	(0.64)	(8.00)	(4.70)	(1.28)
Labor	-4.85***	-1.92	-1.90	-3.20*	-3.57**	-4.01**	-1.48
	(8.42)	(1.79)	(1.28)	(3.51)	(5.59)	(6.59)	(0.56)
Materials	-4.18**	-3.01**	-1.64	-3.31*	-2.19	-2.47	-0.75
	(6.23)	(4.53)	(1.01)	(3.78)	(2.27)	(2.54)	(0.15)
Female Labor	-0.21	-0.16	-0.99***	-0.31	-0.74**	-0.61*	-0.41
	(0.36)	(0.29)	(7.92)	(0.77)	(5.63)	(3.47)	(0.96)
Child Labor	-0.79	-0.54	-0.45	-1.00*	0.10	-0.41	-1.38**
	(2.10)	(1.24)	(0.64)	(3.14)	(0.04)	(0.62)	(4.28)
Trend	-0.75	0.09	0.04	-0.11	0.38	0.04	-0.61
	(1.71)	(0.03)	(0.01)	(0.03)	(0.51)	(0.01)	(0.75)
N	144/14	143/9	144/12	144/5	144/26	144/23	144/4

All estimates are SAS LifeReg Tobit estimates with country fixed effects. Chi-Square statistics are in parentheses. *, **, and *** indicate significance at the 10, 5 and 1 percent level respectively. N=number of observations: total/left censored.

Table 6 By Year Regression Results for Net Exports: Complementarity of Capital and Materials (No Sugar)

Variable	All Years	1870	1880	1890	1900	1910
Constant	-4.867**	1.65	-5.67	6.48	-5.01	6.93
	(4.95)	(0.08)	(0.65)	(0.95)	(0.92)	(1.74)
Capital*Material /Labor	6.79	-2.86***	1.69*	1.94**	2.26***	1.10*
	(1.57)	(12.38)	(3.52)	(6.24)	(14.10)	(3.19)
Female&Child /Labor	-5.06***	-15.67***	-18.69***	-17.72***	-11.12***	-16.81***
	(49.50)	(43.19)	(48.62)	(44.76)	(20.23)	(39.55)
Labor Value	-0.86***	-2.57***	-0.04	1.72*	0.81**	0.84**
	(14.05)	(14.27)	(0.01)	(2.87)	(5.09)	(5.26)
Trend	0.56***					
	(8.15)					
N	1007/93	189/38	196/15	202/12	210/18	210/10

All estimates are SAS LifeReg Tobit estimates with country fixed effects. Chi-Square statistics are in parentheses. *, **, and *** indicate significance at the 10, 5 and 1 percent level respectively. N= number of observation: total/left censored.

Table A.1 Commodity List by SITC Classifiction

Food and Live Animals (0)

Meat (011-013)
Butter (023)
Cheese (024)
Wheat Flour (048)
Sugar Refined (060)
Fish Processed (031-32)

Beverages and Tobacco (1)

Tobacco Manufactures (122)

Crude Materials Inedible Except Fuels (2)

Furskins (212)
Hides (211)
Oil Cake (221)
Wood (242-3)

Mineral Fuels, Lubricants, and Related Materials (3)

Coal (321)
Petroleum Refined (332)

Animal and Vegetable Oils and Fats (4)

Lard (411)
Tallow (411)
Vegetable Oil (421)

Chemicals (5)

Chemicals (Dyes and Dyewoods) (532)
Nitrates, Sodium (530)

Manufactured Goods Classified by Material (6)

Leather (611)
Silk Manufactures (650)
Wool Manufactures (650)
Flax Manufactures (650)
Bagging (650)
Cotton Manufactures (652-53)
Earthenstone (660)
Iron and Steel (670)
Copper Ingots (682)
Tinplate (670)
Cordage & Twine (650)

Machinery and Transport Equipment (7)

Sewing Machines (717)
Agricultural Implements (712)

Numbers in parentheses are the Standard International Trade Classifications of the commodities at the three digit level. Many of the commodities are five or six digit industries.