INTER-INDUSTRY AND INTRA-INDUSTRY SPECIALIZATION IN MANUFACTURED GOODS

by

Bela Balassa
and
Luc Bauwens

May 1987

The World Bank does not accept responsibility for the views expressed herein which are those of the author(s) and should not be attributed to the World Bank or to its affiliated organizations. The findings, interpretations, and conclusions are the results of research supported by the Bank; they do not necessarily represent official policy of the Bank. The designations employed, the presentation of material, and any maps used in this document are solely for the convenience of the reader and do not imply the expression of any opinion whatsoever on the part of the World Bank or its affiliates concerning the legal status of any country, territory, city, area, or of its authorities, or concerning the delimitations of its boundaries, or national affiliation.
Bela Balassa and Luc Bauwens *

* Bela Balassa is Professor of Political Economy at the Johns Hopkins University and Consultant to the World Bank; Luc Bauwens is at the Faculté Catholique de Mons and was Researcher at the World Bank. This paper was prepared in the framework of the World Bank's research project, "Changes in Comparative Advantage in Manufactured Goods" (RPO 672-41). The authors are grateful to Marcus Noland for reviewing alternative explanatory variables and suggesting possible specifications, to Linda Pacheco for data collection, and to Jerzy Rozanski for generating the trade data. However, they alone are responsible for the opinions expressed in the paper that should not be interpreted to reflect the views of The World Bank.
INTER-INDUSTRY AND INTRA-INDUSTRY SPECIALIZATION
IN MANUFACTURED GOODS
Bela Balassa

Abstract

This paper examines the determinants of bilateral trade in manufacturing industries, including the factors affecting inter-industry as well as intra-industry specialization. The results provide support for the Heckscher-Ohlin theory of comparative advantage as well as for the hypotheses put forward in the literature on intra-industry specialization. The paper further indicates the importance of gravitational factors in bilateral trade.

The estimates relate to trade in 152 industries among 38 major developed and developing country exporters of manufactured goods. The findings are confirmed by estimates for trade in manufactured goods among developed countries, among developing countries, as well as between developed and developing countries.
INTER-INDUSTRY AND INTRA-INDUSTRY SPECIALIZATION
IN MANUFACTURED GOODS
Bela Balassa and Luc Bauwens

In earlier papers, the authors examined the determinants of inter-industry (Balassa and Bauwens, 1985) and intra-industry (Balassa and Bauwens, 1984) trade in manufactured goods in the framework of multi-country and multi-industry models. The first paper was designed to explain the pattern of net trade (exports less imports or net exports) between pairs of countries in terms of interindustry differences in factor intensities and intercountry differences in factor endowments; the second paper investigated the effects of country characteristics and industry characteristics on the extent of intra-industry specialization in trade between pairs of countries.

The present paper combines the two approaches in the framework of a multi-country and multi-industry model. It analyses the determinants of gross trade between pairs of countries in individual industries. While net trade is affected by comparative advantage, gross trade is also influenced by the extent of intra-industry specialization, which increases exports as well as imports in bilateral trade. Furthermore, bilateral flows are affected by gravitational factors.

In the model estimated in this paper, trade flows are measured as country j's exports of product i to country k. In the event of complete inter-industry specialization, the gross exports of product i in trade between any two countries will equal net exports, since a country will export but not import a product in which it has a comparative advantage. In turn, in the event of complete intra-industry specialization, net exports will be zero.
The joint occurrence of inter- and intra-industry specialization will then make gross exports to exceed net exports, when trade between pairs of countries is further influenced by gravitational variables.

The model thus includes three sets of variables affecting bilateral trade in individual products (industries). They are: (a) variables affecting comparative advantage, such as factor intensities and factor endowments; (b) variables influencing intra-industry trade, such as country characteristics and industry characteristics; and (c) variables representing gravitational factors, such as distance and common language and culture.

The study is limited to manufactured goods, where differences in natural resource endowments do not enter into the determination of comparative advantage. It covers 38 countries whose manufactured exports exceeded $300 million, and accounted for at least 18 percent of their total merchandise exports, in 1979. 1/ Apart from trade among all the countries concerned, estimates have been made for trade among developed countries, among developing countries, as well as between developed and developing countries. Eighteen countries with per capita incomes of $2254 or higher in 1973 2/ have been

---

1/ While data for 1971 are used in estimating the model, the year 1979 has been chosen as the benchmark in determining the choice of countries for the investigation in order to include all countries with a potential to export manufactured goods.

2/ In order of their per capita GNP, the countries in question are Switzerland, United States, Sweden, Denmark, Germany, Australia, Canada, Norway, France, Belgium, Netherlands, Japan, Finland, Austria, United Kingdom, Israel, Italy, and Ireland.
included in the developed, and twenty countries with per capita incomes of $2031 or lower in 1973 ¹/ in the developing, country group.

The investigation covers altogether 152 product categories in the manufacturing sector as defined by the United States Standard Industrial Classification (SIC), with the exclusion of natural resource products whose manufacture is importantly affected by the availability of natural resources in a particular country. ²/ The classification scheme has been established by merging 4-digit SIC categories in cases when the economic characteristics of particular products have been judged to be very similar. ³/

Sections II and III of the paper describe the hypotheses to be tested in regard to inter-industry and intra-industry specialization and provides the definitions for the relevant variables. Section IV lists the gravitational variables utilized. Section V provides information on the econometric formulation and on the method of estimation. Finally, Section VI presents the results for trade among all the countries under consideration, among developed

---

¹/ In order of their per capita incomes, they are Spain, Singapore, Greece, Argentina, Hong Kong, Portugal, Yugoslavia, Mexico, Brazil, Taiwan, Malaysia, Tunisia, Korea, Morocco, Turkey, Egypt, Thailand, Philippines, India, and Pakistan.

²/ The investigation excludes foods and beverages (SIC 20), tobacco (SIC 21), non-ferrous metals (SIC 333), as well as several 4-digit categories covering textile waste, preserved wood, saw mill products, prefabricated wood, veneer and plywood, wood pulp, dyeing and tanning extracts, fertilizers, adhesives and gelatin, carbon black, petroleum refining and products, asbestos and asphalt products, cement and concrete, lime, gypsum products, cut stone products, and lapidary work. It also excludes ordnance (SIC 19), for which comparable trade data are not available.

³/ The principal criteria have been high substitution elasticities in production and in consumption.
countries, among developing countries, and between developed and developing countries.

II

Following an earlier paper by the authors (1985), comparative advantage is defined with respect to industry and country characteristics. Industry (product) characteristics refer to factor intensities, expressed as the value of physical capital per worker \( p_i \) and the value of human capital per worker \( h_i \). In turn, country characteristics refer to the endowments of physical capital \( G_j \) and human capital \( H_j \), expressed in per capita terms.

In the earlier paper, the hypothesis was tested that, in trade between pairs of countries, relative capital abundance is associated with the net exports of capital intensive commodities. In the present paper, this hypothesis will be tested in regard to gross exports. As in the earlier paper, it will be tested for physical capital and for human capital, taken separately.

The estimating equation used in the earlier paper was derived utilizing a two-stage procedure. In the first stage, normalized net exports of product \( i \) from country \( j \) to country \( k \) \( (\text{NNX}_{jki}) \) \(^1\) were regressed on physical \( (p_i) \) and human \( (h_i) \) capital intensities as in (1). \(^2\) This was done for bilateral trade between countries \( j \) and \( k \), such that \( j>k \). In the

---

1/ Net exports of commodity \( i \) from country \( j \) to country \( k \) were normalized by dividing with the sum of exports and imports of commodity \( i \) in trade between countries \( j \) and \( k \).

2/ In the following discussion, we do not introduce residuals in the equations. For a discussion on these and the estimation method, see Balassa and Bauwens (1985).
second stage, the estimated coefficients, $\beta^{P}_{j\k}$ and $\beta^{h}_{j\k}$ were regressed, respectively, on the relative physical and human capital endowments of country $j$ with respect to country $k$ as in (2a) and (2b).  

\begin{align}
(1) \quad \text{NNX}_{jki} &= \alpha_{jk} + \beta^{P}_{j\k} \ln p_i + \beta^{h}_{j\k} \ln h_i \\
(2a) \quad \beta^{P}_{j\k} &= a^P + b^P \ln \frac{G^i_j}{G^i_k} \\
(2b) \quad \beta^{h}_{j\k} &= a^h + b^h \ln \frac{H^i_j}{H^i_k}
\end{align}

Substituting the right hand sides of these last two equations into the first yields equation (3) that was estimated in one step.

\begin{align}
(3) \quad \text{NNX}_{jki} &= \alpha_{jk} + a^P \ln p_i + a^h \ln h_i + b^P \ln \frac{G^i_j}{G^i_k} \ln p_i + b^h \ln \frac{H^i_j}{H^i_k} \ln h_i
\end{align}

explanatory variables $\ln \frac{G^i_j}{G^i_k} \ln p_i$ and $\ln \frac{H^i_j}{H^i_k} \ln h_i$ are interaction terms between the relative endowment of $j$ with respect to $k$ in a given factor, and the intensity of use of this factor in the production of product $i$. In turn,

2/ Experiments were also made by including the human and the physical capital endowment variables in equations (2a) and (2b), respectively. The lack of statistical significance of the estimates was taken as an indication of the high degree of substitution between physical and human capital.
the coefficients $\ln p_i$ and $\ln h_i$ are the constants of the second stage equations.

Data on the capital stock, employment, value added, and wages used in calculating physical and human capital intensities originate from the U.S. Census of Manufacturing and are averages for the years 1969 and 1970. Data on unskilled wages for the same period have been taken from the *Monthly Labor Review*, published by the U.S. Bureau of Statistics; they pertain to the 2-digit industry group, thus involving the assumption that unskilled wages are the same within each 2-digit group.

Capital intensity has been defined in terms of stocks. Physical capital intensity has been equated to the value of the capital stock per worker while human capital intensity has been derived as the discounted value of the difference between the average wage and the unskilled wage using a 10 percent discount rate. ¹/

The trade data used in the investigation relate to 1971. They have been obtained from the GATT tapes. The commodity classification scheme employed has required the use of trade data down to the 5-digit level. In a few cases when 5-digit data were not available, they have been estimated from the 4-digit data on the basis of the worldwide composition of trade.

---

¹/ Apart from a stock flow measure of capital intensity, in the earlier paper (1985) use has also been made of a flow measure, defined as non-wage value added per worker (physical capital) and the difference between the average wage and the unskilled wage (human capital). The two measures gave similar results and, in view of the high computer cost of estimating a large model, only the stock measure has been used here.
The sum of gross fixed investment over the seventeen year period between 1954 and 1970, estimated in constant prices and converted into U.S. dollars at 1967 exchange rates, has been used as a proxy for physical capital endowment for the countries concerned. Investment values have been assumed to depreciate at a rate of 4 percent a year, reflecting the obsolescence of capital, with capital equipment assumed to have a useful life of 17 years. The relevant information has been obtained from the World Bank economic and social data base, and the estimates have been expressed in per capita terms.

The Harbison-Myers index of education has been used as a proxy for human capital. The index is derived as the secondary school enrollment rate plus five times the University enrollment rate, both calculated in their respective age cohorts. It is a flow measure and estimates pertaining to 1965 have been utilized as an indicator of a country's general educational level, and thus its human capital base, in 1971.

III

As explained in an earlier paper by the authors (1984), intra-industry specialization is affected by country and by industry (product) characteristics. The former pertain to pairs of countries; they include average per capita incomes, income inequality, average country size, and size inequality. The latter pertain to individual industries; they include product differentiation, marketing costs, plant economies of scale, industrial concentration, and offshore assembly. ¹/

¹/ Some of the country characteristics included in the earlier paper (1984) will now appear as gravitational factors because they affect both inter-industry and intra-industry trade.
Ceteris paribus, gross exports will be the greater, the greater is the extent of intra-industry trade. Correspondingly, the present paper will investigate the proposition that the variables which increase (reduce) the extent of intra-industry trade will also increase (reduce) gross exports. In the following, the individual hypotheses will be stated in a summary form; for details and references, see Balassa and Bauwens, 1984.

**Country characteristics**

(1) Similarity in income levels has been said to contribute to intra-industry trade, which involves the exchange of differentiated products. Correspondingly, it will be hypothesized that the extent of intra-industry trade between any two countries is negatively correlated with differences in their income levels, measured by per capita GNP.

(2) Intra-industry trade has been said to increase with the rise of incomes that augments demand for differentiated products. It will thus be hypothesized that the extent of intra-industry trade between any two countries is positively correlated with their average per capita incomes, measured by per capita GNP.

(3) Similarity in country size has been said to contribute to intra-industry trade by equalizing conditions in the exportation of differentiated products manufactured under economies of scale. Accordingly, it will be hypothesized that the extent of intra-industry trade between any two countries is negatively correlated with differences in their size, measured by the gross national product.

(4) Intra-industry trade has been said to increase with country size that permits increasing the number of differentiated products manufactured under economies of scale. It will, then, be hypothesized that the extent of
intra-industry trade between any two countries is positively correlated with their average size, measured by the gross national product.

**Industry Characteristics**

1. As noted above, intra-industry trade is associated with product differentiation. Correspondingly, it will be hypothesized that the extent of intra-industry trade is positively correlated with the degree of product differentiation. Two measures of product differentiation have been used in the present study:
   
   (a) the dispersion of prices (unit values) within each 7-digit SITC category;
   (b) the ratio of marketing, planning, and support costs to total costs, and

2. Conversely, seasonal and border trade apart, intra-industry trade is not expected to occur in standardized products. It will thus be hypothesized that the extent of intra-industry trade is negatively correlated with the degree of product standardization. Two measures of product standardization has been used in this investigation:
   
   (a) plant economies of scale, measured by dividing the ratio of the average size of the larger plants in U.S. industry, accounting for approximately one-half of industry shipments, to total industry shipment by the ratio of value added per worker in the smaller establishments, again accounting for one-half of industry shipments, to value added per worker in the larger plants.
   (b) the concentration ratio, adjusted for the extent of import competition.
(3) It has been said that offshore assembly provisions tend to lead to intra-industry trade by encouraging the international division of the production process. Correspondingly, it will be hypothesized that the extent of intra-industry trade is positively correlated with the relative importance of offshore assembly, measured as the ratio of imports exempted from duties under offshore assembly provisions to total U.S. imports on industry.

IV

Gravitational models have been used to explain bilateral trade in all products, taken together, by reference to variables that positively or negatively affect the extent of trade between pairs of countries without, however, introducing variables that determine inter-industry or intra-industry trade (Linneman, 1966). In the present investigation, gravitational variables have been used in conjunction with variables affecting inter-industry and intra-industry specialization to explain bilateral trade in individual products (industries). This has involved testing the following hypotheses:

(1) Ceteris paribus, bilateral trade will tend to decline with the cost of transportation. Accordingly, it will be hypothesized that trade between any two countries is negatively correlated with the geographical distance between them, which is used as a proxy for transport costs.

(2) Conversely, bilateral trade will be enhanced by the existence of common borders between any two countries. It will, then, be hypothesized that

---

1/ It is customary to include in gravitational models a variable for country size to act as a "scalar" since trade tends to increase with the size of the trading partners. Such a variable has not been utilized in the present paper as the average GNP variable, described in conjunction with intra-industry trade, will act as a scalar. This assumes symmetry as to the effects of the country size on trade between any two countries.
more trade occurs between countries that share a common border than between countries which do not have common borders, denoted by a dummy variable.

(3) Bilateral trade will also be enhanced by the existence of low trade barriers in the countries in question. Thus, it will be hypothesized that more trade occurs between countries that have lower trade barriers than between countries with high barriers.

(4) Participation in integration schemes will further contribute to trade among the participating countries. Correspondingly, it will be hypothesized that more trade occurs between any two countries which are members of a particular integration scheme than between countries which are not members. In the present investigation, dummy variables have been introduced for participation in the European Common Market, the European Free Trade Association, and the Latin American Free Trade Association.

(5) Common language and cultural ties will also contribute to bilateral trade. It will then be hypothesized that more trade occurs between any two countries with common language and cultural ties than between two countries without such ties. This hypothesis will be tested in regard to the English, French, Spanish, German, Portuguese, and Scandinavian language groups.

Equation (4) used in estimation incorporates the three sets of variables affecting the exports of product i from country j to country k,
denoted by $x_{jki}$. The dependent variable is measured in logarithms, in order to ensure the positivity of predicted trade flows.

\begin{equation}
\ln x_{jki} = \beta_0 + \beta^{e'} z_{jki}^e + \beta^{a'} z_{jki}^a + \beta^{g'} z_{jk}^g + u_{jki}
\end{equation}

In the equation, $z_{jki}^e$ denotes the vector of variables affecting inter-industry trade, i.e. the interaction terms between the relative factor endowments and factor intensities described in Section II. By definition, these interaction terms are anti-symmetrical with respect to the country indices ($z_{jki}^e = -z_{kji}^e$). In turn, $z_{jki}^a$ is the symmetrical vector of variables influencing intra-industry trade ($z_{jki}^a = z_{kji}^a$). Finally, $z_{jki}^g$ is the vector of the symmetrical gravitational variables ($z_{jk}^g = z_{kj}^g$).

Equations (5) and (6) may be derived from equation (4) and the properties of the explanatory variables stated previously (assuming $u_{jki} = 0$).

\begin{equation}
\frac{1}{2} (\ln x_{jki} + \ln x_{kji}) = \beta_0 + \beta^{a'} z_{jki}^a + \beta^{g'} z_{jk}^g
\end{equation}

\begin{equation}
\frac{1}{2} (\ln x_{jki} - \ln x_{kji}) = \beta^{e'} z_{jki}^e
\end{equation}

1/ Country indices $j$ and $k$ take values from 1 to 38 for $j \neq k$. Since imports of country $j$ from country $k$ are equal to exports of $k$ to $j$, there is no need to introduce imports in a separate equation.

2/ The variables $lnp_i$ and $lnh_i$ are not included in equation (4), although they were included in estimating equation (3) of the previous study. In the latter case, the coefficients of these variables are the constants of equation (2), which means that they are essentially adjustment terms for the level of the $\beta$ coefficients. Such an adjustment is not required in the case of equation (4). Also, $lnp_i$ and $lnh_i$ would influence gross trade in the same way as do the variables affecting intra-industry trade and the gravitational variables in equation (5) below but would not influence net trade as the interaction terms in equation (6).
Equation (5) shows that the geometric mean of \( X_{jki} \) and \( X_{kji}' \), which is a measure of gross trade between countries \( j \) and \( k \) in product \( i \), depends on the variables affecting intra-industry trade and on the gravitational factors, but is independent of the variables influencing inter-industry trade. In turn, equation (6) shows that the ratio of \( X_{jki} \) to \( X_{kji}' \), which is a measure of discrepancy between exports and imports, hence of net trade, depends on the interaction terms representing the comparative advantage of countries \( j \) and \( k \) in regard to product \( i \), but it is independent of both variables affecting intra-industry trade and gravitational factors.

There are large numbers of zero observations; there are further observations near to zero. Correspondingly, use has been made of the Tobit estimation procedure that involves transforming (4) into (7). In (7) it is assumed that the disturbances \( u_{jki} \) are independent, and each of them has a normal distribution with mean 0 and variance \( \sigma^2 \).

\[
\ln X_{jki} = \beta_o + \beta' Z_{jki} + u_{jki} \quad \text{if} \quad \beta_o + \beta' Z_{jki} + u_{jki} \geq \ln 0.1 \\
= \ln 0.1, \quad \text{if} \quad \beta_o + \beta' Z_{jki} + u_{jki} < \ln 0.1
\]

with \( Z'_{jki} = (Z_{jki}^e, Z_{jki}^{a'}, Z_{jki}^{g'}) \) and \( \beta' = (\beta_e', \beta_a', \beta_g') \)

Under this formulation, unobserved trade flows (including those with a value less than $0.1 million) are assumed to be generated in the same way as
the observed flows, but since they are not observed, all we know about them is that the event $\beta_0 + \beta Z_{jki} + u_{jki} < \ln 0.1$ has occurred. Given the normality assumption on $u_{jki}$, the probability of this event is a function of the parameters to be estimated ($\beta$ and $\sigma^2$). Hence, the knowledge of the values of the explanatory variables corresponding to the unobserved flows provides information on the parameters. The observed trade flows and the corresponding values of the explanatory variables provide information on the parameters as in the usual regression model. These two sets of information are combined in the likelihood function (Amemiya, 1984) shown in (8).

\begin{equation}
L = \prod_{0} \phi \left[ \sigma^{-1}(\ln 0.1 - \beta Z_{jki}) \right] \prod_{1} \phi \left[ \sigma^{-1}(\ln X_{jki} - \beta Z_{jki}) \right]
\end{equation}

where $\prod \phi (\prod)$ denotes that the product has taken over all trade flows less than 0 (greater than or equal to 0.1)

$\phi(y) = (2\pi)^{-1/2} \int_{-\infty}^{y} \exp \left( -\frac{1}{2} t^2 \right) \, dt$, i.e. the standard normal distribution,

$\phi(y) = (2\pi)^{-1/2} \exp \left( -\frac{1}{2} y^2 \right)$, i.e. the standard normal density.

Estimation has been done by the maximum likelihood procedure. 1/

1/ The authors thank Gordon Hughes of Cambridge University for providing his maximum likelihood package (MLPACK). A quasi-Newton method has been used with an analytic gradient and Hessian matrix while the asymptotic covariance matrix of the parameters has been estimated by evaluating minus the inverse of the Hessian at the maximum likelihood estimate.
**Table 1: Explanation of Trade in Manufactured Goods Among the Major Exporters of These Products**

<table>
<thead>
<tr>
<th></th>
<th>Trade Among All Countries</th>
<th>Trade Among Developed Countries</th>
<th>Trade Among Developing Countries</th>
<th>Trade Between Developed and Developing Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Constant</strong></td>
<td>17.127 (119.34)</td>
<td>14.269 (37.98)</td>
<td>22.111 (33.53)</td>
<td>17.710 (74.33)</td>
</tr>
<tr>
<td>ln Gj/Gk lnqi</td>
<td>0.349 (73.21)</td>
<td>0.178 (11.32)</td>
<td>0.051 (2.50)</td>
<td>0.392 (61.66)</td>
</tr>
<tr>
<td>ln Hj/Hk lnhi</td>
<td>0.109 (15.40)</td>
<td>-0.126 (8.77)</td>
<td>0.233 (10.70)</td>
<td>0.123 (12.40)</td>
</tr>
<tr>
<td>INEQ Y/P</td>
<td>-1.647 (166.53)</td>
<td>-1.157 (2.58)</td>
<td>2.556 (10.23)</td>
<td>-2.115 (26.54)</td>
</tr>
<tr>
<td>ln AY/P</td>
<td>2.293 (97.47)</td>
<td>1.712 (14.85)</td>
<td>2.041 (24.20)</td>
<td>2.100 (30.32)</td>
</tr>
<tr>
<td>INEQ Y</td>
<td>-3.095 (55.92)</td>
<td>-3.158 (32.98)</td>
<td>-2.310 (40.58)</td>
<td>-3.235 (37.08)</td>
</tr>
<tr>
<td>ln AY</td>
<td>2.617 (166.53)</td>
<td>2.204 (64.74)</td>
<td>2.874 (31.18)</td>
<td>2.813 (115.57)</td>
</tr>
<tr>
<td>PD</td>
<td>1.054 (28.97)</td>
<td>1.204 (23.67)</td>
<td>0.727 (5.40)</td>
<td>1.121 (20.56)</td>
</tr>
<tr>
<td>MKT</td>
<td>21.792 (44.11)</td>
<td>20.000 (28.42)</td>
<td>29.494 (16.63)</td>
<td>23.127 (31.11)</td>
</tr>
<tr>
<td>ECSC</td>
<td>-11.259 (26.46)</td>
<td>-9.070 (15.94)</td>
<td>-14.974 (9.33)</td>
<td>-12.757 (19.95)</td>
</tr>
<tr>
<td>IACR</td>
<td>-10.105 (54.55)</td>
<td>-8.929 (37.74)</td>
<td>-12.831 (15.87)</td>
<td>-11.196 (39.70)</td>
</tr>
<tr>
<td>OAP</td>
<td>0.310 (4.70)</td>
<td>-</td>
<td>-</td>
<td>0.451 (4.56)</td>
</tr>
<tr>
<td>ln D</td>
<td>-1.646 (126.60)</td>
<td>-1.242 (56.40)</td>
<td>-2.575 (49.65)</td>
<td>-1.651 (74.76)</td>
</tr>
<tr>
<td>BORDER</td>
<td>0.411 (6.11)</td>
<td>0.754 (10.66)</td>
<td>-0.050 (0.21)</td>
<td>1.116 (7.06)</td>
</tr>
<tr>
<td>ATO</td>
<td>1.937 (96.73)</td>
<td>2.100 (18.26)</td>
<td>2.393 (40.58)</td>
<td>2.137 (65.79)</td>
</tr>
<tr>
<td>EEC</td>
<td>0.556 (5.84)</td>
<td>0.790 (9.40)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>EFTA</td>
<td>2.333 (37.98)</td>
<td>1.848 (31.01)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>LAFTA</td>
<td>1.607 (5.66)</td>
<td>-</td>
<td>3.855 (8.16)</td>
<td>-</td>
</tr>
<tr>
<td>ENGLISH</td>
<td>1.376 (37.47)</td>
<td>0.792 (10.94)</td>
<td>1.743 (11.16)</td>
<td>1.251 (19.19)</td>
</tr>
<tr>
<td>FRENCH</td>
<td>1.671 (13.37)</td>
<td>0.412 (1.91)</td>
<td>3.971 (6.51)</td>
<td>2.128 (13.00)</td>
</tr>
<tr>
<td>GERMAN</td>
<td>0.883 (5.37)</td>
<td>0.961 (7.08)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>SCANDIANAVIAN</td>
<td>0.600 (4.79)</td>
<td>0.709 (6.66)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>SPANISH</td>
<td>1.863 (10.76)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>PORTUGUESE</td>
<td>1.423 (4.52)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>$\delta^2$</td>
<td>20.479 (193.02)</td>
<td>12.252 (129.60)</td>
<td>6.657 (53.00)</td>
<td>24.29 (134.64)</td>
</tr>
<tr>
<td>N</td>
<td>213,712</td>
<td>46,512 (129.60)</td>
<td>57,760</td>
<td>109,440</td>
</tr>
<tr>
<td>DEGREE OF CENSORING</td>
<td>57.65</td>
<td>20.33</td>
<td>85.88</td>
<td>49.46</td>
</tr>
</tbody>
</table>

*Source: See Text*
VI

Table 1 reports the results of estimation for trade (a) among all the 38 major exporters of manufactured goods, (b) among 18 developed countries, (c) among 20 developing countries, and (d) between the developed and the developing countries covered by the investigation. We will report first the results obtained for the trade of the entire group of countries, followed by a discussion of the results in the other three cases.

The estimates for the entire group of countries included in the investigation confirm the hypotheses put forward earlier. All the regression coefficients have the expected sign and they are highly significant statistically.

To begin with, the results provide support to the Heckscher-Ohlin theory of international specialization, inasmuch as the relative factor intensity of trade is shown to be positively correlated with relative factor endowments; the more capital (labor) abundant is country j relative to country k, the more capital (labor) intensive will be its exports to that country. As shown by the positive signs of interaction terms \( \ln \frac{G_j}{G_k} \ln p_i \) and \( \ln \frac{H_j}{H_k} \ln h_i \), this conclusion applies equally well to physical and to human capital.

The results further confirm the hypotheses put forward by various authors concerning the effects of country characteristics on intra-industry trade. Thus, it has been shown that trade flows between any two countries are the greater (a) the smaller are differences in their per capita incomes (\( \text{INEQ} Y/P \)), (b) the higher their average per capita income (\( \text{AY/P} \)), (c) the smaller
are differences in country size (INEQ Y), and (d) the greater is their average size (AY). 1/

Among industry characteristics, both measures of product differentiation -- price dispersion (PD) and marketing (MKT) -- are positively correlated with trade as it was hypothesized. In turn, the expected negative correlation is obtained in regard to variables representing product standardization, including plant economies of scale (ECSC) and industrial concentration (IACR). Finally, offshore assembly provisions (OAP) positively contribute to international trade flows as it was to be expected.

The results also confirm the relevance of gravitational factors for the pattern of international trade. Thus, trade between any two countries is negatively correlated with geographical distance (D) between them whereas the existence of common borders (BORDER) tends to increase the extent of such trade. High trade barriers (ATO) 2/ represent another impediment to bilateral trade.

It is further apparent that economic integration contributes to trade among the participating countries. This conclusion applies equally well to

1/ The first two hypotheses pertain to demand factors and the later two to supply factors. Note further that the inequality measure utilized in the present investigation takes values between 0 and 1, when w refers to the ratio of the particular characteristic in country j to the sum of this characteristic in country j and partner country k.

\[
\text{INEQ} = 1 + \left[ w \ln(w) + (1-w) \ln(1-w) \right] / \ln 2
\]

2/ In the absence of data on the height of trade barriers in a number of countries, deviations between actual and hypothetical per capita exports have been used as a proxy for trade orientation, with hypothetical values having been derived from a regression equation incorporating per capita incomes, population, the rate of mineral exports to GNP, and distance from foreign markets as explanatory variables. (For a detailed explanation and the estimating equation actually employed, see Balassa and Bauwens, 1984.)
the European Common Market (EEC), the European Free Trade Association (EFTA), and the Latin American Free Trade Association (LAFTA), which have been considered in the present investigation.

Similar results have been obtained in regard to language and cultural groups. Thus, members of these groups tend to trade more with each other than with non-members. This is shown by the positive signs of the regression coefficients for the English, French, German, Scandinavian, Spanish, and Portuguese language and cultural groups.

Developed countries are not members of LAFTA; they do not belong to the Spanish and Portuguese language groups; and offshore assembly has little relevance for trade among them. Correspondingly, these variables have been eliminated from the estimating equation for trade among the developed countries. All the remaining gravitational variables are highly significant statistically, except for the French dummy variable.

The results obtained for the developed country group confirm the hypotheses described earlier, the exception being the human capital variable. In the latter case, a negative rather than a positive sign is obtained, possibly reflecting the statistical noise associated with the fact that differences among developed countries in terms of human capital endowments are small.

In the period of investigation, EEC and EFTA did not have developing country members, the exception being Portugal in the case of EFTA. Nor do any developing countries belong to the German or Scandinavian language and cultural groups. Correspondingly, these variables have been omitted in making estimates for trade among developing countries. The offshore assembly variable has also been excluded as it has little relevance to these countries.
All the remaining variables other than that representing border trade are highly significant statistically, and confirm the relevant hypotheses in the estimates for trade among developing countries except in the case of the per capita income inequality variable. In the case of border trade, the intercorrelation between participation in LAFTA and the existence of common borders may have influenced the results.

For reasons adduced in regard to developed and to developing countries, in the estimating equation for trade between the two groups of countries, the EEC, LAFTA, as well as the German, Scandinavian, Spanish, and Portuguese language and cultural group variables have been eliminated. The remaining variables are again highly significant statistically; they confirm the suggested hypotheses in every case.

Conclusions

This paper has examined the determinants of international trade in manufactured goods in 152 industries among 38 major exporters of manufactured goods. It has considered the impact on bilateral trade in individual industries of the factors affecting inter-industry and intra-industry specialization, together with that of gravitational factors.

The empirical results obtained for trade among the entire group of countries support the hypotheses put forward in the paper. To begin with, it is apparent that the relative capital intensity of exports is positively correlated with relative capital abundance. This conclusion applies equally well to physical and to human capital.

\[1/\] It should be noted that the proportion of unobserved tradeflows in 86% in trade among developing countries. This very high degree of censoring may be the cause of these unexpected results.
While factors determining comparative advantage explain inter-industry specialization, or unidirectional trade, a variety of factors contribute to intra-industry specialization, or mutual trade among pairs of countries. The results show that trade between any two countries is positively correlated with their average per capita income and country size and negatively correlated with intercountry differences in these variables. Also, product differentiation tends to increase and product standardization reduce intra-industry, and hence total, trade. Finally, offshore assembly has a positive impact on intra-industry trade.

Among gravitational factors, distance is a barrier to trade whereas the existence of common borders has the opposite effect. High trade barriers also hinder bilateral trade. Finally, participation in integration schemes as well as common language and culture tend to promote trade among the countries concerned.

The geographical disaggregation of the estimates indicates the robustness of the results. Thus, the estimates for trade among developed countries, among developing countries, and between developed and developing countries support the stated hypothesis, the only exception being the human capital intensity of trade in the first case and per capita income inequality in the second.

This paper has successfully tested hypotheses pertaining to intra-industry and inter-industry trade, as well as the effects of gravitational factors, in the framework of a multi-country and multi-industry model. The results further indicate the complementary character of inter-industry and intra-industry specialization in determining international trade flows.
REFERENCES


Some Recent DRD Discussion Papers


281. Mobility, Skill and Information, by O. Stark and E. Katz.


286. Coordination of Taxes on Capital Income in Developing Countries, by P.B. Musgrave.

287. The Effects of Labor Regulation Upon Industrial Employment in India, by P.R. Fallon.

288. Factor Substitution in Production in Industrialized and Less Developed Countries, by D. Demekas and R. Klinov.

289. On the Effect of Subsidies to Basic Commodities on Inequality in Egypt, by S. Yitzhaki.


291. Effects of Exchange Rate Changes in Developing Countries, by B. Balassa.

292. Public Enterprise in Developing Countries: Issues of Privatization, by B. Balassa.