Some Doubts on the Current Paradigma of Intra-Industry Trade

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1. Introduction

Research on the phenomenon of intra-industry trade (IIT) has witnessed a boom in the last few years. Theoretical and empirical work is in progress. An inspection of the literature reveals a disequilibrium between theoretical and empirical research. In our view there is an excess of theoretical explanations. This is one justification for making another empirical study on IIT; the other is our uneasiness about the empirical tests of the "mainstream paradigma" of IIT.

It is therefore the purpose of this paper to enrich the empirical IIT literature with some new features. There are two distinct approaches to the study of IIT, the *"industry approach"*, and the *"country approach"*. In the first, industry-specific explanations for IIT are put forward. After testing the "mainstream explanations", "product cycle" and "uncertainty" related hypotheses are tested. The cross-industry tests are made for a selected sample of countries (IIT with the rest of the world). In the second part of the paper we test whether the "mainstream country-specific characteristics" are able to explain bilateral trade flows between industrial countries. First this test is done — as in many other studies — for manufactured goods only. Then we use the same exogenous variables to explain not only "intra-industry goods" but also "Ricardo" and "Heckscher-Ohlin goods". The results are evaluated against existing literature, and cast some doubts upon the current paradigma of IIT.

We do not present completely new theoretical arguments, but introduce ideas common in industrial economics and uncertainty theory.

2. Theoretical hypotheses explaining intra-industry trade

2.1 Industry hypotheses

Several hypotheses on the sources of intra-industry trade can be tested by investigating the IIT ratios for product groups. This task can be performed at different levels of aggregation and for different countries. The most recent survey of theoretical and empirical work on IIT and a discussion of unresolved issues was presented by *Greenaway — Milner* (1986, 1987). Even a short review of the causes of IIT reveals a great deal of subjectivity; not only do different authors present alternative versions of theoretical explanations of IIT, but the underlying theories are not easily distinguishable from each other.

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The mainstream explanation

The current paradigma of the IIT literature assumes that heterogeneous products (in monopolistic markets) cum economies of scale lead to intra-industry trade (see *Deardorff*, 1983). This implies, as far as the industry-specific explanations of IIT are concerned, that those industries which produce more heterogeneous products and/or can exploit considerable economies of scale should — ceteris paribus — show higher IIT shares in their foreign trade.

One of the causes of economies of scale is fixed costs of capital; this leads many authors to make the further assumption that product groups with large IIT should be capital intensive (see *Markusen's,* 1986, world with a capital abundant North and a labour abundant South). A minority of authors, however, representing the view that "intra-industry specialization is not expected to occur in standardized commodities" denies, at least implicitly, that IIT should be higher for capital intensive goods. In empirical work then, *product heterogeneity* and *economies of scale* are the most commonly tested determinants of the structure of IIT with positive correlations, expected in both cases(1). *Market structure* (imperfection of markets) is a third pillar of empirical tests. Capital intensity is not often tested (probably because it is seen as one possible sub-category of economies of scale).

The product cycle explanation

Partly as a complement, partly as an alternative to the current paradigma, *product cycle arguments* can be used as an explanation of IIT. According to *Grubel — Lloyd* (1975, p. 104ff) the product cycle model (PC) and, as they call it, the economies of scale model, are rivals insofar as the PC model can explain IIT, given legal or natural protection for innovations, if goods have identical input requirements and there are no economies of scale. On the other hand, they can be complements if, under the initial umbrella of protection, economies of scale develop(2).

The major difference between the product cycle explanation and mainstream explanations is that in the former the size of firms, capital intensity, and size-based economies of scale do not play a dominant role. Heterogeneity of products is common to both hypotheses. Nevertheless, product cycle theory would suggest that it is due to the emergence of new products, product characteristics, etc., while mainstream theory stresses the importance of marketing strategies. Furthermore product cycle theory asserts that IIT is larger in sectors, that depend on human capital, whereas, for mainstream theory, fixed costs of capital play a decisive role (for tests of the PC model, see *Finger — De Rosa,* 1979).

As far as trade between equally developed countries is concerned, the *product cycle hypothesis* combined with a special or soft variant of economies of scale seem to be able to explain IIT. Firms in developed countries with approximately the same per-capita income

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strive independently of each other for the development of new products, and are successful in this process. This may result in a random choice out of all technically feasible innovations for different products (or variants of products). During the innovation process a firm gains *experience-based economies of scale* (*EBES*; learning curve) and starts to export these goods. In a similar way, a competing firm realizes economies of scale in another specialized market. It is important to note that this type of economies of scale does not imply that larger firms have lower unit costs than smaller firms at any point in time (*size-based economies of scale: SBES*). These economies of scale are a function of time elapsed since the beginning of product development. This point is important because many empirical studies make it appear doubtful whether large firms are more profitable; and several empirical studies on IIT did not find support for a positive connection between *IIT* and *SBES.*

The *product cycle theory* may present a link between factor proportion explanations of international trade and the heterogeneity argument for IIT phenomena. If a country is abundant in human capital, it will specialize in products in which qualified labour is required in the first phase of the product cycle. The production of these products requires material inputs that are produced by other firms but belong to the same statistical category. The techniques used for the production of such inputs are rather standardized, requiring physical capital, energy, and cheap labour. Vertical disintegration of this kind may yield large IIT's, but the unit value of the imports of the highly developed countries will be low; at the same time the exports will have a high unit value.

The uncertainty explanation

A third source of IIT may be from the *uncertainty* present in the international market. We will now argue the possibility of a negative relationship between the level (or the share) of IIT and the degree of uncertainty on international markets. Firms are less informed about the market development in other countries than in their own (see the well-known argument by Adam Smith, namely that foreign trade is more risky than domestic business). The higher the foreign trade uncertainty, the higher this (information) cost factor(3).

Theoretically, the postulated negative relationship can be established by reference to various models of international trade. One such model is *Krugman's* (1979) simple general equilibrium model of international trade. It demonstrates that economies of scale can give rise to (IIT) trade even when there are no international differences in tastes, technology, or factor endowments. The number of goods produced (and traded) is inversely related to the cost structure. Hence, higher (additional) "uncertainty" costs may dominate the economies of scale effect and may strengthen this negative relationship(4).

Another example is the model by *Brander — Krugman* (1983), in which the rivalry of oligopolistic firms serves as an independent cause of international trade and leads to two-way (or IIT) trade in identical products. For the sake of simplicity, we will model the costs of uncertainty as a component of transport costs. Shipping one unit of a good abroad results in unit export costs of g', consisting of transport costs proper g and costs of uncertainty. The larger uncertainty (measured by the standard deviation of foreign demand σ) the larger this cost component. Transport costs are modelled in the following way: Of the exported quantity x, only the proportion $g'x$ arrives in the foreign market:

$$(1) \quad g' = g + \sigma.$$

We can now substitute this cost structure into the *Brander — Krugman* (1983) model. Assuming two identical countries ("domestic" and "foreign"), each country has one firm producing commodity $Z\,(Z^*)$ under constant and identical cost conditions. Each firm regards each country as a separate market and therefore chooses the profit-maximizing quantity for each country individually. Domestic (Π) and foreign (Π^*) profits can be written as

$$(2) \quad \Pi = x\,p\,(Z) + x^*p^*(Z^*) - c\left(x + \frac{x^*}{g'}\right) - F,$$

$$(3) \quad \Pi^* = y\,p\,(Z) + y^*p^*(Z^*) - c\left(\frac{y}{g'} + y^*\right) - F^*,$$

where

$x\,(y^*)$ = output of the domestic (foreign) firm for domestic consumption,
$x^*(y)$ = output for foreign consumption,
$p\,(p^*)$ = domestic and foreign price,
$F(F^*)$ = fixed costs, symmetric in both countries.

Each firm maximizes profits with respect to own output. The solution of this problem yields the trade equilibrium. Solving these first-order conditions (omitted here) for the foreign share in the domestic market $\left(\mu = \frac{y}{Z}\right)$ and letting $\varepsilon = \frac{-p}{Z\,p'}$, the elasticity of domestic demand, we arrive at equation *(4)*. By symmetry, the same result is obtained for the foreign country (market share of the domestic country in the foreign market). Equation *(5)* yields a negative relation between μ (assuming that the IIT ratio is a linear function of μ) and σ (uncertainty):

$$(4) \quad \mu = \frac{\varepsilon\,(g + \sigma - 1) + 1}{(1 + g + \sigma)},$$

$$(5) \quad \frac{\partial \mu}{\partial \sigma} = \frac{2\varepsilon - 1}{(1 + g + \sigma)^2} < 0.$$

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Brander — Krugman (1983) show that even in the absence of economies of scale

- a two-way trade equilibrium exists under which marginal revenue in each country is equated to marginal cost, while in the foreign market higher export costs are equated to higher marginal revenue,

- cross-hauling may or may not improve welfare, depending on whether the competition enforcing effect or the cost inefficiency effect dominates. In the case of free entry, cross-hauling unambiguously increases welfare.

Since we have modelled uncertainty costs exactly parallel to transport costs, these results hold also for uncertainty costs. The smaller these costs the larger the extent of cross-hauling, and therefore the resulting ratios of IIT.

The interpretation that the main costs arising from engaging in foreign trade are costs of information (increasing with the volatility of foreign demand) and not physical transportation costs seems plausible. As a matter of fact, the importance of transport costs diminishes over time. For manufactured goods in particular, which are traded between industrial countries in the same geographical area and the same international community, the share of transport costs in total costs is small. What remains important is therefore costs of information, differences in the legal systems, in market features, in institutions, factors determining the time shape and demand volatility of a specific foreign market, as well as uncertainty with regards to exchange rates. These costs, much more related to uncertainty than to physical transport problems, seem to be the true barriers to the extensive use of scale economies. We will interpret country-specific variables in explaining IIT (distance, border trade, language group) in a similar way.

In presenting these different strands of explanations for IIT separately (mainstream theory, product cycle theory, uncertainty hypothesis), we want to stress that there are bridges between them. Clearly, if the production factor capital is disaggregated, e. g., into physical, human, and knowledge capital, then factor proportion theory can explain a lot of phenomena otherwise left to "other" theories. It is also clear that if we disaggregate even further into factors such as "experience in producing French cars" and "experience in producing German cars", we can unambiguously extend the explanatory power of factor proportion theory. Product cycle theory is an alternative to mainstream theory if size induced economies of scale and capital intensity are part of the latter, but very close to mainstream theory if experience-based economies of scale are considered and if capital intensity refers to human instead of to physical capital. Uncertainty related explanations may also be based on economies of scale and heterogeneity; the degree of uncertainty (however measured) may itself be (negatively) related to the degree of heterogeneity. The fact that the available theories are not "distinct" will always cast doubt on empirical findings, whether they verify or falsify them.

2.1.1 *Methodology*

We have tried to test the above mentioned hypotheses with two sets of data. The main data set used is the *U. N. World Trade Data Bank*. Its data are available for many countries and for many years, but the explanatory variables that can be culled from this set refer mainly to trade flows (exports, imports, unit values).

The second data set is an Austrian data set (*Audoklassys*) which tries to bridge the gap between trade and production statistics. From this data set more variables such as concentration, profits, economies of scale in the technical sense, but also profitability, and capital intensity can be checked for their influence on IIT(5).

We tested the determinants of cross-industry IIT at the 3-digit level of the international as well as the Austrian statistics. IIT_i was calculated according to the *Grubel — Lloyd* (1975) measure for intra-industry trade:

$$(6) \quad IIT_i = 100 - \frac{|X_i - M_i|}{(X_i + M_i)} \cdot 100,$$

where

X_i = exports of industry or good i,
M_i = imports of industry or good i (trade with the rest of the world).

The calculations were carried out only for *manufactured goods* (excluding raw materials, agricultural products, and energy); more precisely we used the 3-digit level of SITC 5 to 8 (revised II) and of ISIC 2 to 5, respectively. Within this group of manufacturing goods we did not investigate further whether a portion of the 3-digit group is in some sense resource determined and should be excluded from the investigation. The tests were performed on the whole set of 150 and of 102 products, respectively, in contrast to some studies(6) which omitted a lot of positions for various specified or unspecified reasons. In following this strategy we have to accept low coefficients of determination, but we prefer this approach over the alternative of ad-hoc exclusion of commodity groups which destroy some presumed theoretical relation.

In order to test the three strands of hypotheses the following variables were constructed:

1. *For the mainstream explanation:* As variables for *heterogeneity*, we used the number of products in the 3-digit (ISIC) group (for Austria), the variation of the unit value for the same products across the OECD countries (SITC according to the U. N. World Trade Data), and the profit margin (for Austria, sales minus purchases and wages divided by sales). All these variables had been proposed in the literature. We had no data on advertising outlays on the branch level, nor did other studies encourage us to calculate employment per establishment or to invest more effort into calculating the number of products in SITC groups according to different schemes.

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We measured *economies of scale* in many different ways, though all of them refer to some sort of scale economies at one point in time ($SBES$, essentially comparing the performance of small and large firms), not to economies of scale due to experience or the length of production runs ($EBES$). The first measure relates the value added of small firms to the average of the 3-digit branch, the second that of large firms to the average, a third compares the profit margin of the 4 largest enterprises to that of the average. We calculated capital intensity by summing up two investment programmes (1976, 1983), and we related their average to the value added (depreciation data are not available).

To capture such effects as market structure, we constructed a *concentration measure* by relating the employment in the 4 largest firms to those of all firms (without making adjustments for exports and imports).

2. *For the product cycle explanation:* The *product cycle hypothesis* was tested by calculating the differences of export and import unit values. We investigated whether firms exported products with below-average unit values (indicating economies of scale) or products with above-average unit values. The difference in export and import unit values for individual countries and sectors is taken to indicate that firms do not export and import identical products or near substitutes (produced according to identical production functions), but very different products and/or products of different technological standards.

In order to differentiate IIT by factor contents, we employed the goods classification of *Legler* (1982). He classified all 3-digit SITC groups into 10 goods categories by factor content. The criteria were derived from West-German production and input data. The ten product groups are called (according to their factor intensity): Human-capital (HC), high-technology (HT), applied-technology (AT), physical-capital (PC), labour intensive (LB), scale-economies (SC), agricultural-resources (AR), mineral-resources (MR), energy intensive (EN), and pollution intensive (PL). One must take into consideration, however, that Legler's goods classification is not exclusive, but overlapping. This means that goods of HC are also included in PC etc. Mainstream explanations of IIT predict more intensive IIT in products with economies of scale and in capital intensive goods; product cycle explanations predict intensive IIT in high-technology goods or in those with large human capital inputs. All in all, IIT should be low in resource intensive industries.

3. *For uncertainty explanations:* The *uncertainty hypothesis* implies that the standard deviation over time (in a 3-digit industry) is negatively related to IIT. The standard deviation of changes in exports and imports was calculated over a 4-year period (1982-1986); this assumes that the uncertainty with regard to foreign markets can be assessed either by the variation in exports of a specific country or of the world market (as measured by OECD import growth volatility). In contrast to the expected negative correlation between export market uncertainty and IIT, there should be no statistically significant relationship between proxies for home market uncertainty, e. g., volatility of production or consumption.

2.1.2 The empirical results

Before presenting the empirical results we want to stress their limitations and to repeat the usual caveats, namely, that the exogenous variables used for the tests are really poor proxies for the "true" determinants. Time pressure forced us to restrict our work to some of the variables used in the literature. The calculations were performed for a single year in the 1980s (all results in the following tables refer to the year 1984). We tested the hypotheses only with linear regressions. One might argue, however, that the industry-specific factors explaining IIT exhibit non-monotonic relationships, and it would have been more adequate to use non-linear regression techniques.

2.1.2.1 The Austrian data set

Table 1 presents the results of the regression analysis of Austria's IIT in manufactured goods in 1984. None of the variables used as a proxy for *heterogeneity* showed a significant influence on IIT. Similarly, no variable which measures *economies of scale* had the expected (positive) sign and proved to be significant. Value added per employee (*EC-VAA*) for all firms as well as that for the 4 largest firms (*EC-VL4*), attained significant negative coefficients. The same is true if we restrict our analysis to ISIC groups 3 to 5. *Capital intensity* and *concentration measures* exhibited negative signs for the more broadly defined ISIC categories (2 to 5), but not for those restricted to ISIC 3 to 5. Mainstream theory predicts a positive influence, a result which we were not able to reproduce.

The only variable which is statistically significant in explaining Austria's industry-specific IIT ratios is the measure for *uncertainty*, namely, the standard deviation of export growth over time (1982-1986). The results hold for both definitions of ISIC groups (2 to 5 and 3 to 5) and both for IIT with the rest of the world and with the OECD countries only. An indicator for market uncertainty was not available. The fact, however, that the IIT is not (significantly) related to the standard deviation of (apparent) consumption growth in Austria indicates that it is uncertainty with regard to foreign markets but not to some characteristics of the home market which matters in explaining IIT.

Multiple regression results for Austria's IIT in manufactured goods in 1984 are given in Table 2. In the best regression — from the point of statistical fit — the industry-specific variables explain about one quarter of Austria's IIT. It must be noted, however, that the variables measuring economies of scale and those representing capital intensity have the wrong sign compared to theoretical mainstream explanations. Only the coefficients of the variables representing uncertainty have the correct sign and are significant.

Indicators on economie
scale
Expected sign: +

EC-VAA
EC-VL4
EC-V4A
EC-VAS
EC-PM4
EC-P4A

Indicators on concentr
and capital intensity
Expected sign: +

CI-ISA
CI-EM4

Indicators on heteroge
Expected sign: +

HET-PD
HET-PMF
HET-PMP

Economies-of-scale me

EC-VAA = value a
EC-VL4 = value a
EC-V4A = value a
EC-VAS = value a
EC-PM4 = profit m
EC-P4A = profit m

Capital intensity measu

CI-EM4 = market
CI-ISA = investm

Heterogeneity measure

HET-PD = numbe
HET-PMF = profit m
HET-PMP = profit m

their limitations and to repeat the for the tests are really poor prox- o restrict our work to some of the erformed for a single year in the 1984). We tested the hypotheses that the industry-specific factors would have been more adequate

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Table 1

Explanation of cross-section IIT in Austria

OLS, 1 explanatory variable

	Total exports and imports				OECD exports and imports	
	Including mining ISIC 2 to 5		Excluding mining ISIC 3 to 5		ISIC 3 to 5	
	t-values	R^2	*t*-values	R^2	*t*-values	R^2
Indicators on economies of scale Expected sign: +						
EC-VAA	—4.66	0.206	—3.67	0.146	—3.01	0.103
EC-VL4	—4.24	0.176	—3.73	0.149	—3.13	0.110
EC-V4A	—1.30	0.020	—2.31	0.063	—2.14	0.055
EC-VAS	—0.08	0.000	1.54	0.029	0.72	0.006
EC-PM4	0.25	0.000	0.10	0.000	0.30	0.001
EC-P4A	0.22	0.000	0.02	0.000	0.69	0.006
Indicators on concentration and capital intensity Expected sign: +						
CI-ISA	—1.77	0.033	0.17	0.000	0.10	0.000
CI-EM4	—2.03	0.044	—0.67	0.006	—0.08	0.000
Indicators on heterogeneity Expected sign: +						
HET-PD	—0.15	0.000	—1.01	0.013	0.97	0.012
HET-PMF	0.12	0.000	0.11	0.000	0.14	0.000
HET-PMP	—1.38	0.022	0.96	0.012	0.34	0.001

Economies-of-scale measures:

EC-VAA = value added per employee, industry average,
EC-VL4 = value added per employee, largest 4 firms,
EC-V4A = value added per employee, largest 4 firms minus average,
EC-VAS = value added per employee, average minus small firms,
EC-PM4 = profit margin, largest 4 firms,
EC-P4A = profit margin, largest 4 firms minus average.

Capital intensity measures:

CI-EM4 = market share of the largest 4 firms in 3-digit ISIC,
CI-ISA = investment-sales ratio, average 1976-1983, in 3-digit ISIC.

Heterogeneity measures:

HET-PD = number of products,
HET-PMF = profit margin (firm),
HET-PMP = profit margin (plant).

Table 2

Explanation of cross-country IIT in Austria

Multiple regression results, t-values

	SD-X	*EC-VAA*	*EC-VL4*	*EC-V4A*	*EC-VAS*	*CI-EM4*	*CI-ISA*	R^2
ISIC 2 to 5	—2.50	—2.83					—1.78	0.27
	—2.95		—2.81				—1.94	0.27
	—4.37			—1.62			—2.14	0.22
ISIC 3 to 5	—2.64		—2.60				—0.25	0.20
	—3.56				1.18		—0.39	0.15
	—2.79		—2.72			0.46		0.21

Economies-of-scale measures:

EC-VAA = value added per employee, industry average,
EC-VL4 = value added per employee, largest 4 firms,
EC-V4A = value added per employee, largest 4 firms minus average,
EC-VAS = value added per employee, average minus small firms.

Capital intensity measures:

CI-EM4 = market share of the largest 4 firms in 3-digit ISIC,
CI-ISA = investment-sales ratio, average 1976-1983, in 3-digit ISIC.

SD-X = standard deviation of export growth over time.

2.1.2.2 The U. N. world trade data

A set of countries (Austria, France, Switzerland, Japan, Sweden, and Germany) were chosen in order to test the industry-specific explanations for IIT in manufactured goods in 1984. First, this test was done by single regression technique (see Table 3). We tried to test whether or not measures for *heterogeneity* (standard deviation of unit values across countries and over time) and/or *technological differences* (unit values of exports versus imports in its absolute and relative form) influence IIT. None of these variables showed an significant influence, however (neither positive nor negative). The explanatory power of the 10 goods characteristics (0/1 dummies) of the manufactured goods according to *Legler* (1982) was not satisfactory. The coefficients of high-tech and applied-tech groups were positive (but not significant) for the majority of the 6 countries. Physical-capital intensive and scale economies goods should — according to theoretical reasoning — exhibit a positive sign, but the results were mixed. Hence, there is no support for the mainstream theory. Resource intensive goods usually showed a correct negative sign (and were sometimes also significant). The positive and significant correlation between the resource intensive goods in Germany (agricultural and energy intensive goods) and in Japan (all four resource intensive categories) and IIT must be interpreted as a real blow in the face of any attempt to distinguish between intra- and inter-industry trade.

Table 3

Explanation of cross-section IIT

Single regression results

	Austria		France		Switzerland		Japan		Sweden		Germany	
	t-values	R^2	*t*-values	R^2	*t*-values	R^2	*t*-values	R^2	*t*-values	R^2	*t*-values	R^2
SXCGT	—4.75	0.15	—3.76	0.10	—3.90	0.11	—0.74	0.004	—2.90	0.063	—4.32	0.13
UXC4	0.16	0.00	—0.15	0.00	0.90	0.007					0.76	0.005
SUXCT	—0.15	0.00	—0.47	0.002	0.50	0.002			0.98	0.009	0.89	0.006
SUXC4	0.20	0.00	—0.51	0.002	0.44	0.001	—0.21	0.000	—0.25	0.001	0.12	0.000
DUXMC4	0.44	0.002	—0.25	0.000	1.81	0.026					0.70	0.004
TOT	—0.40	0.001	—0.15	0.000	1.31	0.014					—0.18	0.000
CXMCGT	1.75	0.02	—0.91	0.007	—0.91	0.006	0.06	0.000	—0.34	0.001	—3.41	0.085
DSMCOGT	—0.72	0.01	—2.00	0.03	0.22	0.000	—1.55	0.019	—1.70	0.023	—2.25	0.039
SMOGT	—0.27	0.001	—2.22	0.03	—1.23	0.012	—2.88	0.062	0.41	0.001	—4.38	0.133
HC	—1.02	0.008	—1.35	0.014	0.92	0.006	—0.09	0.000	0.28	0.001	—1.92	0.029
HT	0.25	0.001	0.97	0.007	0.002	0.000	1.18	0.011	—0.35	0.001	0.86	0.006
AT	1.45	0.017	0.10	0.000	1.43	0.016	—0.83	0.005	0.13	0.000	—2.10	0.034
PC	—1.68	0.022	0.01	0.000	—1.63	0.021	3.74	0.101	—0.51	0.018	1.93	0.029
LB	2.57	0.050	0.21	0.000	0.62	0.003	—4.05	0.113	1.64	0.021	—1.92	0.029
SC	—1.52	0.018	—1.84	0.026	0.45	0.002	0.87	0.006	—0.48	0.001	1.30	0.013
AR	0.78	0.005	1.12	0.009	—0.08	0.002	2.35	0.042	—1.55	0.019	2.12	0.035
MR	—2.33	0.041	—0.53	0.002	—0.75	0.005	3.30	0.080	—0.85	0.006	1.45	0.017
EN	—2.37	0.043	—0.11	0.000	—0.76	0.004	3.47	0.088	—0.24	0.000	2.77	0.058
PL	—2.72	0.054	—0.22	0.000	0.32	0.001	3.69	0.098	—0.52	0.002	1.16	0.011

SXCGT = standard deviation of the country's export growth rates over time,
UXC4 = unit values of the country's exports 1984,
SUXCT = standard deviation of the country's export unit values over time,
SUXC4 = standard deviation of export unit values over country 1984,
DUXMC4 = export unit values of the country minus import unit values of the country 1984,
TOT = export unit values of the country minus import unit values of the country 1984, in absolute terms,
CXMCGT = covariance of the country's export and import growth rates over time,
DSMCOGT = standard deviation of the country's import growth rates minus standard deviation of total OECD import growth rates over time,
SMOGT = standard deviation of total OECD import growth rates over time.

HC ... human-capital intensive, *HT* ... high-technology intensive, *AT* ... applied-technology intensive, *PC* ... physical-capital intensive, *LB* ... labour intensive, *SC* ... scale-economies intensive, *AR* ... agricultural-resources intensive, *MR* ... mineral-resources intensive, *EN* ... energy intensive, *PL* ... pollution intensive.

Table 4

Best multiple regressions for cross-industry IIT

t-values

	Austria			France		Germany		Japan	Switzerland	
SXCGT	—4.76	—5.09	—4.87	—3.80	—3.84	—1.32	—0.47		—4.01	—3.52
UXC4				0.90	2.05					
SUXCT				—0.60	—2.00					
SUXC4								0.64		
DUXMC4					—1.90					1.58
TOT				0.43					0.82	
CXMCGT	3.28	3.09	2.53	2.29	2.08	0.84	0.45		1.84	
DSMCOGT	—2.56	—2.80		—2.17	—1.73	—1.96	—1.75			
SMOGT						—3.30	—3.66	—2.87		
HC							—2.09	0.64		
HT										
PC							—0.18	1.92	—0.42	—1.83
LB			1.81							—1.80
SC	—0.88	0.10	—0.22	—1.52	—1.62			—1.43	—0.17	—0.49
EN		—2.56					1.60	1.96		
R^2	0.214	0.249	0.230	0.147	0.170	0.187	0.221	0.167	0.132	0.136

SXCGT = standard deviation of the country's export growth rates over time,
UXC4 = unit values of the country's exports 1984,
SUXCT = standard deviation of the country's export unit values over time,
SUXC4 = standard deviation of export unit values over country 1984,
DUXMC4 = export unit values of the country minus import unit values of the country 1984,
TOT = export unit values of the country minus import unit values of the country 1984, in absolute terms,
CXMCGT = covariance of the country's export and import growth rates over time,
DSMCOGT = standard deviation of the country's import growth rates minus standard deviation of total OECD import growth rates over time,
SMOGT = standard deviation of total OECD import growth rates over time.

HC ... human-capital intensive, *HT* ... high-technology intensive, *PC* ... physical-capital intensive, *LB* ... labour intensive, *SC* ... scale-economies intensive, *EN* ... energy intensive.

Table 5

Dependence of IIT on uncertainty in 12 OECD countries
Single regression results, *t*-values

	SXCGT	*SMOGT*
Austria	—4.75	—0.27
France	—3.76	—2.22
Switzerland	—3.90	—1.23
Japan	—0.74	—2.88
Sweden	—2.90	0.41
Germany	—4.32	—4.38
U. K.	—1.52	—1.40
Italy	—0.82	—2.66
Denmark	—3.19	0.20
The Netherlands	—3.23	0.15
Finland	—2.57	—0.56
Belgium	—0.23	—1.29

SXCGT = standard deviation of the country's export growth rates over time,
SMOGT = standard deviation of total OECD import growth rates over time.

The single most important explanatory variable for IIT is again the measure of *uncertainty* (standard deviation of export growth). It has the expected negative sign for all 6 countries (statistically significant only for 5 countries) in Table 3 (see also the multiple regression results for 5 countries in Table 4). We extended this exercise to 12 OECD countries and were able to reproduce this negative relationship for all countries (statistically significant for 8 of them — see Table 5). The second best explanatory variable for market uncertainty is the standard deviation of OECD import growth. In 5 out of the 6 countries of Table 3 the coefficient is negative as expected (but only significant for 3 countries). Out of the 12 countries 9 showed a negative correlation. There was no significant positive correlation for any country, but the correct negative relationship was only significant in 4 cases.

2.1.3 Interpretation and robustness of the results

The results of the empirical tests concerning the industry-specific hypotheses are in general somewhat disappointing, at least for the mainstream and the product cycle explanation. Data cannot demonstrate a link between the degree of heterogeneity and the industry structure of IIT, nor can they prove any positive link between *IIT* and *SBES*. Resource intensiveness is not negatively related to IIT shares. High-tech industries and those employing qualified labour do not have larger IIT shares. Capital and scale intensity do not seem to influence IIT as postulated by mainstream theory. The results are disappointing maybe because the explanatory variables are not good proxies for the economic variables proposed in the theory. In particular, this seems true for the EOS indicators, none of which measures *EBES*, and for the heterogeneity indicators. It is also possible that a large part of IIT is actually a statistical artifact (large variations of unit values in exports and imports point in this direction).

The only significant influence in the expected direction on IIT is that of the uncertainty variables. Export volatility is negatively related to IIT in all 12 countries, market volatility in 9 of the 12 countries. We checked the robustness of this result in several ways. It did not matter whether we calculated each country's IIT with the rest of the world or with the OECD area alone, whether we changed the year of calculation (1981, 1982, 1983, 1984, 1985), or whether we used SITC revised I or II. We substituted volatility of export growth for the volatility of export levels (coefficients of variation). Finally, the influence of volatility on IIT shares also remained statistically significant and negative, even when we used proxies for resource intensity in order to capture an indirect effect of resource intensity on the volatility of exports (according to the conjecture that basic goods face volatile demand and the uncertainty variable may be an indirect proxy for the existence of non-manufactured goods within SITC 5 to 8).

This leads us to the conclusion that the negative relationship between volatility of foreign demand and the share of IIT should be considered a "stylized fact" for the explanation of IIT. Personally, we are inclined to interpret the results as we proposed in Section 2.1. There are forces which lead to intra-industry trade, such as experience-based economies of scale and the continuous creation of new products. These forces may be counterbalanced by the costs of uncertainty arising from engagement in foreign trade. This can be shown in a model of the *Brander — Krugman* (1983) type or in others. The apparent relationship may also be the result of past efforts of firms to stabilize their demand by making their products less homogeneous (in branches where this has been done successfully the volatility decreases and IIT increases). We are sure that further explanations can and should be developed in order to close the gap between the empirical evidence and theoretical explanations.

2.2 Country hypotheses

The previous sections dealt with determinants of intra-industry trade across industries for selected countries trading with the rest of the world. In the following sections hypotheses are tested concerning intra-industry trade between pairs of countries. For this purpose consideration will be given to general *country-specific characteristics,* including the level of economic development and differences in market size, distance, and the existence of common borders, common language, as well as levels of protection and the participation in integration arrangements.

In the empirical literature (see, e. g., *Lörtscher — Wolter,* 1980, *Balassa,* 1986) a more or less accepted list of country-specific variables is used to examine the theoretical hypotheses concerning the extent of intra-industry trade (see *Greenaway — Milner,* 1987). In theory intra-industry trade is associated with imperfectly competitive product markets where consumer preferences differ, the production function is subject to increasing returns, and/or the markets are segmented. The theoretical explanations are simply "extensions of the analysis of imperfectly competitive product markets in a closed-economy . . . to an open-economy setting" (*Greenaway — Milner,* 1987, p. 42).

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The following hypotheses were examined:

1. In explaining trade with differentiated products, *Linder* (1961) advanced the *"consumer preference similarity" hypothesis.* "The more similar the demand structures of two countries, the more intensive, potentially, is the trade between these two countries" (*Linder,* 1961, p. 94). Since in general high income per capita is associated with a high capital-labour ratio, Linder's hypothesis leads to the conclusion that trade between similar developed countries can no longer be explained by the factor proportion (Heckscher-Ohlin) hypothesis. Evidence for this hypothesis in the context of general equilibrium models was subsequently provided by several authors (for an overview, see *Greenaway — Milner,* 1987, p. 42). Moreover, these general equilibrium models allow for the simultaneous existence of inter- and intra-industry trade (see *Helpman — Krugman,* 1985). Along these lines we employed the absolute difference in 1985 per-capita incomes in PPP U. S. dollars between pairs of 20 OECD countries ($PCID$) to test the Linder hypothesis (*development stage differential*).

2. The *average development stage hypothesis* is a complement to the Linder hypothesis. It states that highly developed countries command a high capability to innovate, to exploit economies of scale, and therefore to produce and trade in highly differentiated products. To test this hypothesis, the *average development stage* of pairs of 20 OECD countries ($PCIA$) was measured as the average of their 1985 per-capita incomes in PPP U. S. dollars.

3. *Market size differentials* may be a potential obstacle to bilateral intra-industry trade. If markets of two countries are large, there is more scope for intra-industry trade than in cases where one country is large and the other small. Market size differentials in bilateral trade also means dependency of small countries on large ones. Such potential *satellite* constellations (implicitly connected with different development stages and therefore different capital-labour ratios) may foster the exploitation of inter-industry trade instead of intra-industry trade. The Heckscher-Ohlin explanation is therefore suitable, and a negative correlation between market size differential and intra-industry trade can be expected. The absolute difference of 1985 GDP in PPP U. S. dollars between pairs of 20 OECD countries ($GDPD$) was used as an indicator for *market size differential.*

4. The *average market size hypothesis* is a complement to the market size differential hypothesis. In large markets, many (differentiated) goods can be produced (potentially) with economies of scale. There may also be a considerable demand for foreign (differentiated) goods. But here, in contrast to the industry-specific explanation where several measures were directly applied, economies of scale can be deduced only indirectly and very generally from the existence of large countries and markets. It is therefore a mere conjuncture that large countries produce more than small countries under conditions of economies of scale. Average 1985 GDP of pairs of 20 OECD countries ($GDPA$) in PPP U. S. dollars was taken as an indicator for *average market size.*

5. In general, the more intensive the intra-industry trade among countries, the fewer *barriers to trade* (in the broadest sense) there will be. Here all tariff and non-tariff barriers are understood to create additional (transaction) costs. In particular, *transport costs* are important (but not only for intra-industry trade). A *distance dummy* ($DIST$), measuring the distance between the pairs of countries in kilometres, is used to approximate transport costs. Neighbouring countries may have a more intensive exchange of similar goods. Therefore a *border trade dummy* ($BOTR$) is used to catch such effects. It is common practice in the literature to also take into consideration such trade promoting factors as common cultural groups or common languages. Here, only a *language group dummy* ($LAGR$) is used to capture such non-economic factors which potentially may foster intra-industry trade. The variables $DIST$, $BOTR$, and $LAGR$ may implicitly also be interpreted as proxies for "uncertainty" connected with the engagement in foreign trade. Finally, dummy variables have been included to represent participation in *integration* arrangements, such as the European Economic Community (EEC) and the Free Trade Association ($EFTA$).

2.2.1 Methodology

The empirical test of the above mentioned hypotheses covers 20 OECD countries trading *manufactured* (156 goods — SITC 5 to 8 according to the Standard International Trade Classification, revised II on a 3-digit level) and *non-manufactured goods* (82 goods — SITC 0 to 4, 3-digits) with each other in 1985. The data base is the U. N. World Trade Data Bank. In contrast to the other empirical studies explaining intra-industry trade among countries by country-specific characteristics, we use not only manufactured goods but also a variety of product groups in order to discriminate between Heckscher-Ohlin explanations of intra-industry trade and non-Heckscher-Ohlin explanations. For this purpose we use the product classification by *Legler* (1982). For the purpose of explaining bilateral intra-industry trade we used only 6 product categories by reducing the 4 resource intensive goods to one goods category and neglecting applied-technology intensive goods. The following hypothesis is tested: Are Ricardo goods (89 resource intensive goods) and Heckscher-Ohlin goods (86 capital and 105 labour intensive goods) equally well explained by the selected country-specific variables as intra-industry goods (89 human-capital, 13 high-tech and 91 economies-of-scale intensive goods)?

Multiple regression technique is applied to explain the weighted intra-industry trade index of bilateral trade among 20 OECD countries in 1985 by the proposed exogenous variables. Taking into consideration the unresolved problems of aggregation (see the discussion in *Greenaway — Milner,* 1987), we applied the most commonly used measure of aggregation, the weighted mean (see *Grubel — Lloyd,* 1975, pp. 21-22):

$$(7)\quad IIT = \left\{ \sum_i^n \left[(X_i + M_i) - |X_i - M_i|\right] \right\} \Big/ \left\{ \sum_i^n (X_i + M_i) \right\} \cdot 100,$$

X_i and M_i refer to exports and imports of industry or commodity i ($i = 1, \ldots, n$; 3-digit level of SITC). Applying the IIT index of equation *(7)* to the bilateral trade flows between 20 OECD countries results in 190 combinations.

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The following relationship is empirically tested (neglecting the suffixes):

$$(8)\quad IIT = \underset{-}{f(PCID}, \underset{+}{PCIA}, \underset{-}{GDPD}, \underset{+}{GDPA}, \underset{-}{DIST}\ \underset{+}{BOTR}, \underset{+}{LAGR}, \underset{+}{EEC}, \underset{+}{EFTA}).$$

The signs below the exogenous variables denote the posited direction of influence according to the hypotheses mentioned above.

2.2.2 *The empirical results*

The empirical estimates for the non-manufactured and manufactured goods are reported in Table 6. The results for *manufactured goods* support the hypotheses put forward regarding the common characteristics of the industrial countries. All variables have the expected sign, but not all are statistically significant. Neither the coefficients of *PCID* (Linder hypothesis)(7), *LAGR* (language group dummy), or of the *EFTA* dummy are significant. Since 1977 there has been no tariff levied on trade in manufactured goods between EEC and EFTA countries. In 1985 therefore, trade relations were stronger within the EEC than within the EFTA. One must also take into account that several EFTA countries have redirected their trade flows from the formerly preferred EFTA to the EEC which stopped practicing discrimination in 1977. In order to allow a check of whether or not the results are influenced by multicollinearity between the variables *PCID* and *PCIA*, as well as between the variables *GDPD* and *GDPA*, alternative runs for the IIT index of manufactured goods are reported in Table 6. The coefficients of *PCID* and of *PCIA* do not seem to be affected by problems of multicollinearity. There might be a problem with multicollinearity with respect to *GDPD* and *GDPA*, however, because the sign of *GDPD* changes from minus to plus if *GDPA* is excluded.

As predicted by Heckscher-Ohlin or Ricardo reasoning, all the exogenous variables which typically explain intra-industry trade are insignificant in explaining IIT for *non-manufactured goods* (they sometimes also have the wrong sign; see Table 6). Only variables which generally explain trade intensity, such as transport costs (*DIST*) as well as border trade (*BOTR*), are significant. Integration arrangements are not relevant for non-manufactured goods; therefore, the insignificant results are as expected. These results confirm the general expectation: Intra-industry trade is increasingly important in the field of manufactured goods (the IIT index is high), whereas inter-industry trade dominates the trade in non-manufactured goods (the IIT index is low). This is confirmed by the figures for the average IIT index at the bottom of Table 6. As shown in Table 6, the level of the IIT index differs also according to the SITC system used. If one applies SITC, revised I, the average IIT index for manufactured goods is 35, according to SITC, revised II, it is 32.

Table 6

Determinants of intra-industry trade

Bilateral trade among 20 OECD countries 1985

	Endogenous variable: IIT of					
	Non-manufactured goods	Manufactured goods	Manufactured goods			
	SITC 0 to 4	SITC 5 to 8	SITC 5 to 8			
PCID	0.00027	− 0.00021	− 0.00030	− 0.00037	− 0.00063	
	(0.65)	*(0.51)*	*(0.71)*	*(0.89)*	*(1.65)*	
PCIA	− 0.00074	0.00132	0.00151	0.00127		0.00144
	(1.34)	*(2.38)*	*(2.68)*	*(2.28)*		*(2.87)*
GDPD	− 0.00247	− 0.00621	0.00232		− 0.00593	− 0.00648
	(0.84)	*(2.10)*	*(2.25)*		*(1.98)*	*(2.23)*
GDPA	0.00663	0.01614		0.00577	0.01754	0.01633
	(1.27)	*(3.07)*		*(3.18)*	*(3.32)*	*(3.12)*
DIST	− 0.00078	− 0.00199	− 0.00189	− 0.00194	− 0.00190	− 0.00199
	(3.59)	*(9.14)*	*(8.60)*	*(8.88)*	*(8.75)*	*(9.17)*
BOTR	13.46812	11.70830	12.14418	11.91797	11.75776	12.04681
	(3.99)	*(3.45)*	*(3.51)*	*(3.48)*	*(3.42)*	*(3.63)*
LAGR	0.38114	5.81570	5.86060	5.76358	6.98760	5.55051
	(0.11)	*(1.65)*	*(1.62)*	*(1.62)*	*(1.97)*	*(1.59)*
EEC	2.30468	5.17845	6.11272	5.82784	4.21309	5.30894
	(0.90)	*(2.01)*	*(2.34)*	*(2.26)*	*(1.64)*	*(2.08)*
EFTA	2.65113	2.97667	2.32537	3.12250	4.24549	2.70275
	(0.74)	*(0.83)*	*(0.63)*	*(0.86)*	*(1.18)*	*(0.76)*
Constant	26.34240	20.83942	20.38224	22.31152	35.94774	18.84245
	(4.00)	*(3.13)*	*(2.94)*	*(3.33)*	*(16.67)*	*(3.45)*
$\bar{R}^2$	0.236	0.496	0.472	0.486	0.482	0.497
SE	12.22131	12.27037	12.55301	12.38548	12.42771	12.24523
N	190	190	190	190	190	190
Average IIT index(1)	19	32	32	32	32	32

PCID = development stage differential (Linder hypothesis),
PCIA = average development stage (product differentiation),
GDPD = market size differential (satellite constellation),
GDPA = average market size (economies of scale),
DIST = distance dummy (transport costs),
BOTR = border trade dummy,
LAGR = language group dummy,
EEC = EEC dummy,
EFTA = EFTA dummy.

Numbers in parentheses . . . *t*-values.

Regression coefficients for the weighted IIT index, 3-digit SITC, revised II. — (1) Manufactured goods: SITC, revised I, IIT index = 35.

Table 6

trade

ntries 1985

ble: IIT of

Manufactured goods

SITC 5 to 8

0.00037	— 0.00063	
(0.89)	*(1.65)*	
0.00127		0.00144
(2.28)		*(2.87)*
	— 0.00593	— 0.00648
	(1.98)	*(2.23)*
0.00577	0.01754	0.01633
(3.18)	*(3.32)*	*(3.12)*
0.00194	— 0.00190	— 0.00199
(8.88)	*(8.75)*	*(9.17)*
11.91797	11.75776	12.04681
(3.48)	*(3.42)*	*(3.63)*
5.76358	6.98760	5.55051
(1.62)	*(1.97)*	*(1.59)*
5.82784	4.21309	5.30894
(2.26)	*(1.64)*	*(2.08)*
3.12250	4.24549	2.70275
(0.86)	*(1.18)*	*(0.76)*
22.31152	35.94774	18.84245
(3.33)	*(16.67)*	*(3.45)*
0.486	0.482	0.497
12.38548	12.42771	12.24523
190	190	190
32	32	32

revised II. — (1) Manufactured goods:

Table 7

Determinants of intra-industry trade

Bilateral trade among 20 OECD countries 1985

	Endogenous variable: IIT of					
	HC goods	*HT* goods	*SC* goods	*PC* goods	*LB* goods	*AR, MR* goods
PCID	— 0.00041	— 0.00160	0.00015	0.00065	— 0.00077	0.00011
	(0.96)	(2.72)	(0.34)	(1.38)	(1.77)	(0.21)
PCIA	0.00195	0.00195	0.00127	0.00029	0.00180	— 0.00058
	(3.41)	(2.47)	(2.22)	(0.46)	(3.07)	(0.83)
GDPD	— 0.00666	— 0.01437	— 0.00984	— 0.00976	— 0.00409	— 0.01340
	(2.18)	(3.40)	(3.21)	(2.90)	(1.31)	(3.57)
GDPA	0.01822	0.03100	0.02277	0.02119	0.01266	0.02597
	(3.35)	(4.12)	(4.17)	(3.54)	(2.27)	(3.89)
DIST	— 0.00239	— 0.00258	— 0.00204	— 0.00158	— 0.00230	— 0.00071
	(10.63)	(8.28)	(9.04)	(6.37)	(9.99)	(2.57)
BOTR	8.04519	7.89046	11.16061	14.66351	8.34917	11.12948
	(2.29)	(1.63)	(3.17)	(3.80)	(2.33)	(2.58)
LAGR	6.21713	4.90124	4.62915	0.78257	9.74547	1.28589
	(1.70)	(0.97)	(1.26)	(0.19)	(2.60)	(0.29)
EEC	2.79518	— 0.16749	5.16091	2.74014	3.89916	2.46886
	(1.05)	(0.05)	(1.93)	(0.94)	(1.43)	(0.75)
EFTA	4.52434	— 2.05647	4.37534	4.70490	— 0.19436	0.41555
	(1.22)	(0.40)	(1.17)	(1.15)	(0.05)	(0.09)
Constant	16.54234	26.49903	18.49988	23.59475	21.42674	32.95022
	(2.38)	(2.78)	(2.63)	(3.13)	(3.03)	(3.85)
$\bar{R}^2$	0.522	0.414	0.485	0.357	0.506	0.169
SE	12.70948	17.56019	12.74921	13.96894	12.99220	15.60127
N	190	190	190	190	190	190
Average IIT index	33	37	31	28	34	29

PCID = development stage differential (Linder hypothesis),
PCIA = average development stage (product differentiation),
GDPD = market size differential (satellite constellation),
GDPA = average market size (economies of scale),
DIST = distance dummy (transport costs),
BOTR = border trade dummy,
LAGR = language group dummy,
EEC = EEC dummy,
EFTA = EFTA dummy.

HC ... human-capital intensive, *HT* ... high-technology intensive, *PC* ... physical-capital intensive, *LB* ... labour intensive, *SC* ... scale-economies intensive, *AR* ... agricultural-resources intensive, *MR* ... mineral-resources intensive.

Numbers in parentheses ... *t*-values.

Regression coefficients for the weighted IIT index, 3-digit SITC, revised II (goods categories defined by *Legler*, 1982).

We now turn to the new element in testing the significance of the theoretical hypotheses explaining intra-industry trade for different goods categories. The results are reported in Table 7. Using *Legler's* (1982) definition of 6 goods categories covering all 3-digit SITC (revised II) goods, we test the proposition that the IIT index for Ricardo goods (resource intensive goods) and Heckscher-Ohlin goods (capital and labour intensive goods) is not as well explained by the country-specific variables as is the IIT index for intra-industry goods (human-capital intensive, high-tech intensive and economies of scale goods). The Linder hypothesis is confirmed only for high-tech goods. The integration dummies (for EEC and EFTA) are insignificant for all goods categories. The language group dummy ($LAGR$) is significant only for labour intensive goods. For capital and resource intensive goods the variable representing the possibility of product differentiation ($PCIA$) is insignificant. For labour intensive goods, the market size differential ($GDPD$) has no significant effect on intra-industry trade. All other exogenous variables are significant in explaining the IIT index of the 6 goods categories.

Given the statistical problems concerning the aggregation of SITC categories, as well as the ambiguity in the definition of goods categories (Legler's definition) it is understandable but nevertheless disappointing that the explanatory variables of intra-industry trade failed to discriminate clearly between intra-industry goods and other goods(8). Although it is theoretically possible to discriminate between inter- and intra-industry trade within the same model setting (see *Helpman — Krugman*, 1985, *Markusen*, 1986), the empirical evidence has not been very illuminating. The only factual difference between the 6 goods categories is revealed in their levels of the average IIT index (bottom of Table 7). As expected, the IIT index is highest for IIT goods.

3. Conclusions

The results of this paper add to the growing scepticism about the explanatory power of *"mainstream arguments"* of the IIT literature, and point out that the traditional explanatory variables cannot be neatly separated according to differences in the factor proportions (Heckscher-Ohlin). The explanatory power of all the explanations tested is very low, especially that of the *industry-specific* characteristics of IIT. The theoretical implications that IIT should differ by resource intensity were not born out by the data, neither at the intra-country nor at the cross-industry level. On average, the unit values of exports and imports differ from each other by more than 50 percent (even at the 3-digit level), contradicting the contention that "approximately the same products" are exported and imported, and casting doubts on the presumption that the inputs used in sub-categories with high IIT were approximately the same.

The attempts to explain cross-industry differences were not successful. The results were particularly disappointing for that version which we have labeled the mainstream approach; this approach claims that IIT results from the trade of *differentiated products* each pro-

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duced by a country with *economies of scale* (which themselves may be due to considerable fixed costs of capital). We found that the level of IIT in individual industries is negatively related (or unrelated) to capital intensity and concentration. Several regressions indicate that it is also negatively related to economies of scale (in the sense of differences between large and average firms).

Such *negative relations* between IIT and specific forms of *economies of scale* have also been found in other studies, and are even expected in some, since IIT should be higher for less standardized products, those for which economies of scale are of minor importance. Once we give up the presumption of economies of scale and capital intensity and stress that in modern industrial life new products are created simultaneously in each industry and that, especially in the first phase of a product cycle, products are heterogeneous, skill intensive and not standardized, we may then arrive at a *product cycle* explanation of IIT. Each country produces those goods for which they have a comparative advantage. The source of the comparative advantage may be a special factor availability (in which case we are near a Ricardo or Heckscher-Ohlin explanation of inter-industry trade) or just chance (perhaps an early start in production, a patent, the headquarters of a firm). The advantage itself is some sort of *experience-based economies of scale* ($EBES$). For adherents to the mainstream hypothesis who have always had this form of economies of scale in mind, there is not much difference between the two explanations. The evidence for the product cycle approach is primarily the failure to find a positive coefficient on capital intensity and the concentration variable, but some of the regressions with Legler's goods characteristics do provide weak support (positive coefficients for labour intensity and high-tech products) for this view. The *unit value* variables were not successful in explaining IIT. In a slight majority of countries exports are concentrated in industries with above-average unit values. This specialization pattern, however, varies with GDP per capita. This result is consistent with a product cycle story, but not with the utilization of *size-based economies of scale* ($SBES$).

A hypothesis not found in the literature is that *IIT* should be *negatively related to uncertainty* in foreign markets. Foreign markets are risky; this risk should be evaluated against the cost advantages that may be due to moderate economies of scale. The volatility of trade flows (as measured by the standard deviation of exports of an individual country over time or the same measure for total OECD imports as a proxy for *market uncertainty*) was the single most powerful variable in explaining IIT across industries for all selected countries. There may well be other interpretations of the explanatory power of this variable. (The standard deviation over time may again be a measure of the cyclical character of the goods categories: Resource intensive goods, characterized by low levels of IIT, exhibit heavier fluctuations than more sophisticated goods which are characterized by high levels of IIT.) Although the theoretical model relating IIT to uncertainty has yet to be elaborated, we would like to propose this relationship as a new stylized fact for the IIT literature. *Cross-industry differences* in the *IIT* seem to be *negatively related to the time volatility of exports and imports.*

As far as *country-specific* explanations are concerned, we were able to reproduce (more or less) the *mainstream results* of the IIT literature for bilateral IIT in manufactured goods. IIT between pairs of countries can be explained by *country characteristics* such as the level of economic development and differences thereof, the size of domestic markets and differences in market size, the membership in integration communities, distance, and the existence of common borders as well as of common language groups.

There are very few attempts in the literature to falsify the country-specific approach by trying to explain not only intra-industry trade with this set of exogenous variables but also inter-industry trade. In order to discriminate between Heckscher-Ohlin and intra-industry specific explanations of bilateral trade flows we used Legler's goods categories. Due to several statistical problems (aggregation, overlapping goods definition) the results were not as clear-cut as one might wish. Nevertheless, IIT of Heckscher-Ohlin goods is explained almost as well by the same country-specific factors as intra-industry goods.

Our doubts on empirical "mainstream IIT" research do not lead us to reject the good together with the bad and to conclude — as some authors have done — that intra-industry trade is mainly a statistical artifact. Instead we propose further research in this field!

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5. Notes

(1) Professor Helpman, in a discussion with the authors, maintained that this explanation of IIT did not have any testable implications for the industry-specific explanation of IIT. Regarding economies of scale, he stressed that most measures of economies of scale compare firms at one point in time instead of over a time period.

Caves (1981, p. 211), however, expects IIT and economies of scale to be negatively related, since scale economies confine production to few locations, thereby reducing the potential for intra-industry trade.

(2) *Grubel — Lloyd* (1975, p. 104) distinguish between the technology-gap model for activities leading to improvements in the production method, while the term product cycle trade in the narrower sense is confined to innovations in styling or the performance of goods.

(3) We have demonstrated elsewhere (*Aiginger*, 1987) that the costs of uncertainty vary, depending on the attitude toward risk, the market structure, the technology, and the asymmetry of plan revisions.

(4) Similar results can be derived for a model in which each firm faces a downward sloping demand curve in the home country with certainty, but considers its position on the world market as one of a pricetaker under demand uncertainty. Details about such models are available from the authors on request.

(5) These issues are explored in *Köppl — Reisinger-Chowdhury* (1987).

(6) *Lörtscher — Wolter* (1980) exclude approximately one half of the 3-digit SITC groups because of lack of sufficiently reliable data. For an overview of the number of statistical categories excluded and the reasons for doing so, see *Balassa — Bauwens* (1987, p. 924f).

(7) This result concords with *Balassa's* (1986) findings for IIT among developed countries and among developing countries in the year 1979 (p. 119f). On the other hand, *Balassa* (1986) found evidence supporting Linder's hypothesis for IIT among developed and developing countries (combined) as well as — paradoxically — for IIT between developed and developing countries (p. 117, p. 121). *Lörtscher — Wolter* (1980) were also able to confirm Linder's hypothesis for IIT among industrial countries for the years 1971 and 1972.

(8) Similar problems in discriminating between intra-industry specific explanations for IIT and Heckscher-Ohlin explanations were encountered by *Lundberg — Hansson* (1986) in their study of the Swedish manufacturing industry. They concluded that at the 3-digit level industry groups are rather heterogeneous. "This means that we cannot dismiss the hypothesis that intra-industry trade, because of aggregation of activities with differing factor requirements, may be caused by comparative advantage, based on factor proportions, in the same way as inter-industry trade" (p. 147).

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