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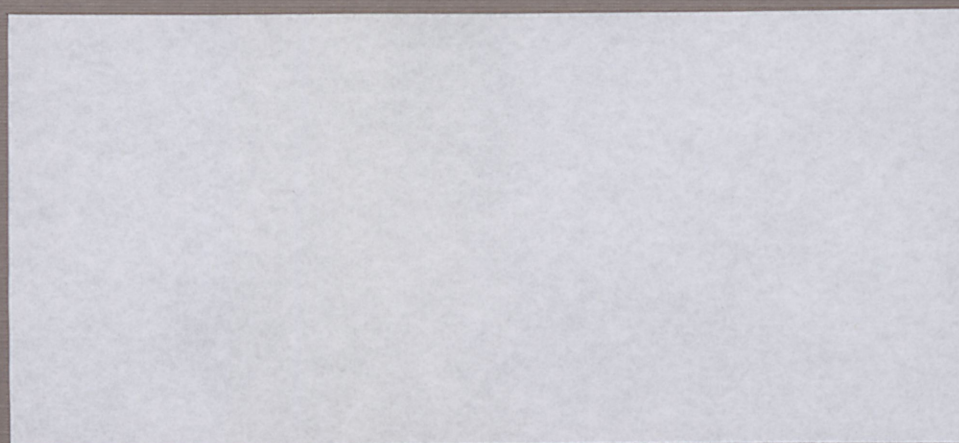
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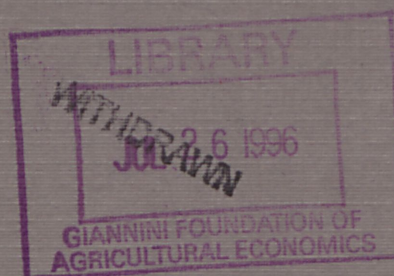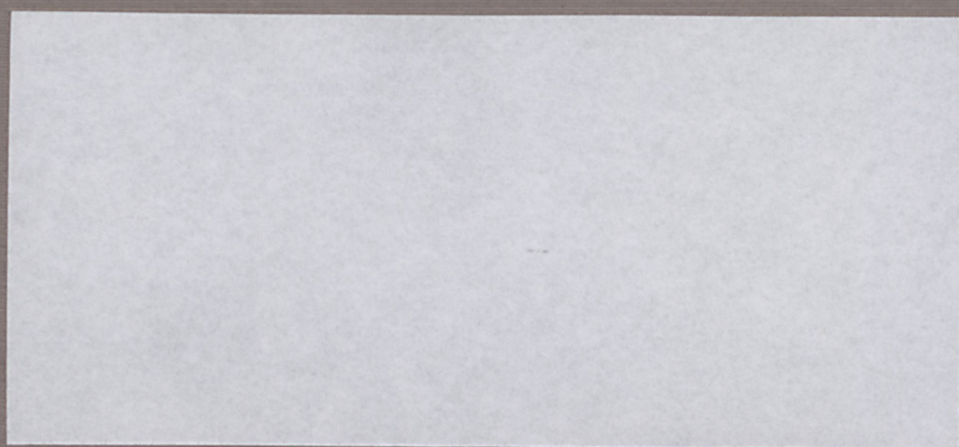
AN ANALYSIS OF BILATERAL INTRA-INDUSTRY TRADE IN THE FOOD PROCESSING SECTOR

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Abstract

This paper analyzes determinants of intra-industry trade in food processing for a thirty country sample over the period 1964-1985. Previous studies have tested the hypothesis that imperfect competition is a major determinant of intra-industry trade (IIT) in the durable goods manufacturing sectors. This study is distinguished from the earlier studies of IIT by; the examination of the processed food sector (SIC=20), the use of a panel data set for 22 years and 30 countries available at the four digit SIC level, the use of purchasing power parity measures of GDP, and the use of a weighted tobit model with fixed effects to account for the censored cross-section time-series nature of the data.

The results indicate that such trade is a positive function of a country's GDP per capita and equality of GDP per capita between countries. In addition, it is also found that a large proportion of this trade is between countries that share common borders and between countries within the European Community.

Keywords: Bilateral, intra-industry trade, food processing.

Introduction

Much of the post-war growth in world trade has been of an intra-industry nature - the simultaneous export and import of products that are very close substitutes for each other in terms of factor inputs and consumption (Tharakan). Such a phenomenon is difficult to explain with neoclassical trade theory. For example, Linder argued that, unlike the Heckscher-Ohlin-Samuelson paradigm, trade would be most intensive between countries with similar per capita incomes, firms in one country specializing in products consumed domestically and exporting them to countries with similar demand structures.

In recent years, a substantial literature has emerged that attempts to explain intra-industry trade. These theoretical developments largely emphasize the existence of imperfect competition in industrial markets, particularly economies of scale and product differentiation. Probably the most developed model to emerge has been that of Helpman and Krugman[1], which incorporates monopolistic competition into a general equilibrium trade model, such that predictions can be made about the relationship between factor endowments, country size and the level of intra-industry trade.

In the context of the Helpman-Krugman model, the objective of this paper is to analyze the determinants of bilateral intra-industry trade in the food processing sector for a sample of thirty countries over the period 1964-1985. This research is important for two reasons. First, while several econometric studies have conducted cross-country/cross-industry tests of the Helpman-Krugman model at a point in time, e.g. Balassa and Bauwens, and Bergstrand, no study, other than an unpublished paper by Noland, has employed the more efficient pooled cross-section/time-series method of estimation. Furthermore, given the censored nature of the data, this paper applies the appropriate tobit model specification. Second, most empirical work on intra-

industry trade has focussed almost entirely on manufactured goods. For example, Balassa and Bauwens explicitly exclude food products from their sample. However, recent empirical work by McCorriston and Sheldon, and Hart and McDonald has shown that intra-industry trade does occur in the processed foods sector, and the level has been growing over time. Hence, it would seem logical to focus on the determinants of such trade in the processed foods sector.

The paper is organized as follows: Section 1 briefly outlines the Helpman-Krugman model of trade, the predictions of which are to be tested for the food processing sector. In Section 2, the variables and estimation procedure are described, while Section 3 presents the results of the econometric analysis. Finally, Section 4 provides a summary of the paper.

1. A Model of Intra-Industry Trade

Helpman and Krugman's model assumes that there are two countries, home and foreign; two factors of production, capital and labor; two industries, one producing a homogeneous good under constant returns to scale, the other producing differentiated goods under an increasing returns technology with capital K and labor L (in the following, the differentiated goods sector refers to food processing). In this type of model, the homogeneous good is produced by a perfectly competitive sector in each country, while the differentiated goods sector has a structure of monopolistic competition in each country, where each firm produces a unique variety of good, the number of varieties being limited in equilibrium by economies of scale and free entry[2]. Hence, with trade, each variety is produced in only one of the two countries.

Following Helpman and Krugman, it is useful to first define the set of world resource allocations that generate a trade outcome similar to an *integrated equilibrium*, i.e. the outcome

that would arise if all factors were perfectly mobile. The dimensions of **Figure 1** show the combined factor endowments of the home and foreign countries. With full employment, this endowment will be fully utilized in the two industries: OQ will be the vector of resources used in the differentiated goods sector, assumed to be capital-intensive in production, and OQ* will be the vector of resources used in the homogeneous good sector, which is labor-intensive in production. In addition, the vector OO* represents aggregate employment, and with appropriate units of measurement, it can be interpreted as the world equivalent of Gross Domestic Product (GDP).

Assuming common knowledge of technologies and identical, homothetic preferences, trade can generate the full employment, integrated equilibrium. Suppose that the home country is evaluated from the origin O and the foreign country from the origin O*. If the allocation of factors is given by the endowment point E, the home country will devote OM resources to the production of n varieties of the differentiated good and OH to the production of the homogeneous good[3]. This solution is derived by constructing a parallelogram between O and E, where a line parallel to OQ* is drawn through E and a line parallel to OQ is also drawn through E. A similar process is followed to derive the foreign country's production levels.

In order to describe the pattern of trade, a negatively sloped function BB is drawn through point E, the slope of which is relative factor prices, w_L/w_K. This line passes through the diagonal OO*, giving the home and foreign countries' income levels; all income being paid to the factors of production and all income being spent. Constructing a parallelogram between O and C, the consumption level of the home country can be derived, with the home country consuming OC_M of the differentiated goods and OC_H of the homogeneous good. By a similar process, the

Figure 1: Trade Equilibrium

consumption levels of the foreign country can also be shown. In this particular equilibrium there is simultaneous inter-industry trade and intra-industry trade. The home country imports the homogeneous good, and is a net exporter $(M - C_M)$ of differentiated goods, while the foreign country is an exporter of the homogeneous good and a net importer of differentiated goods. The concept of net trade flows in the differentiated goods sector follows from the fact that the home country produces and exports n varieties, and imports n* varieties from the foreign country, where n > n*.

From the above analysis, the share of intra-industry trade in total trade can be systematically related to differences in relative factor endowments. Following Helpman and Krugman (see Ch.8., pp.169-178) three testable hypotheses can be stated. First, for given income shares, the level of intra-industry trade will be higher (lower) the greater the equality (inequality) of relative factor endowments between countries. Focussing on C in **Figure 1**, which lies on BB, and moving from endowment point E towards the vector OQ, the level of intra-industry trade will fall as the home country's capital-labor ratio increases, and vice-versa as the endowment point moves towards C on the diagonal OO*. In the limit, there will only be intra-industry trade for endowments on OO*, and if the endowment point were at Q, there would only be inter-industry trade, the home country specializing in producing differentiated goods, the foreign country specializing in the homogeneous good. As a country's income is a function of its capital-labor ratio in this model, the hypothesis can be re-stated as: the level of intra-industry trade will be higher (lower) the greater the equality (inequality) of countries' GDP per capita[4].

Second, the degree of intra-industry trade will be higher (lower), the smaller (greater) the relative size of the capital-rich country, size being measured by GDP. Again with reference to

Figure 1, suppose the initial capital-labor ratio for the home country is as given by the endowment point E, and this is reduced to E´, which maintains the same capital-labor ratio, but reduces GDP of the home country. As the home country is now smaller, the level of intra-industry trade increases, i.e. if the appropriate parallelogram is drawn between O and E´, the gap between M and C_M decreases. If instead the endowment point is on OO*, where each country has the same capital-labor ratio, relative size does not matter and there is only intra-industry trade.

Third, Helpman and Krugman argue that, *a priori*, in more capital-intensive industries, relatively more differentiated goods will be produced. Consequently, it is expected that the degree of intra-industry trade for a specific country will be positively associated with endowments of capital per worker, again measured by a country's per capita income[5].

2. Model Specification

The measure of intra-industry trade used in this study is the unadjusted version of the Grubel and Lloyd index (*IIT*) computed for trade in the processed food sector[6]:

$$(1) \qquad IIT_{jki} = 1 - \frac{|X_{jki} - M_{jki}|}{X_{jki} + M_{jki}}$$

where IIT_{jki} indicates intra-industry trade between country j and country k for industry i. Due to the use of import data throughout the analysis, as importing country (*j*) reports the transactions they are referred to as the reporting country and the exporting country (*k*) as the partner country. The index tends towards one in the case of intra-industry trade and zero for inter-industry trade.

Following Bergstrand, these measures by industry are then averaged to provide sectoral values of IIT_{jk} which are then used for the dependent variable:

(2)
$$IIT_{jk} = \frac{1}{n_{jk}} \sum_{i=1}^{n_{jk}} IIT_{jki}$$

where n_{jk} is the number of industries at the 4-digit SIC level in which countries j and k engage in trade. The data used to compute IIT_{jk} were taken from the D-series trade data compiled by the United Nations. The 30 nations included in this set imported 85% to 90% of world-wide processed food exports during the years 1964 to 1985.

Given the analysis in Section 1, the following three independent variables are defined:

1) $INEQGDC_{jk}$ is an indicator of inequality between the reporting country's GDP per capita (denoted as GDC_j) and the partner country's (GDC_k). Following Balassa and Bauwens, this is defined as:

(3)
$$INEQGDC_{jk} = 1 + \frac{[w_{jk}\ln(w_{jk}) + (1-w_{jk})\ln(1-w_{jk})]}{\ln(2)}$$

where $w_{jk} = GDC_j / (GDC_k + GDC_j)$, and $INEQGDC_{jk}$ varies over the range zero to one. The GDP data are from Summers and Heston and are based on purchasing power parity instead of using national accounts data with a market exchange rate. The use of national accounts data based on purchasing power parity means that the GDP comparisons are based on the cost of purchasing a comparable basket of goods and services. This method removes the influence of certain macroeconomic and policy factors that may only influence exchange rate markets and are not meaningful for international comparisons. The theory predicts that the greater the inequality in GDP per capita, the smaller the level of intra-industry trade.

2) $GDPSIZE_{jk}$ is defined as an index of GDP of the reporting country relative to the partner country. This variable indicates the relative size of the trading partners, given differences in their capital-labor ratios. $GDPSIZE_{jk}$ has non-zero values in cases where the per capita GDP's vary:

$$(4) \qquad GDPSIZE_{jk} = \left(\frac{GDC_k - GDC_j}{GDC_k + GDC_j} \right) \left(\frac{GDP_j}{GDP_k} \right)$$

When per capita incomes are different this implies that capital endowments differ; thus, the ratio of GDPs should be important in determining the level of IIT_{jk}, otherwise it should not have an influence. If the reporting country GDC_j is greater than the partner country GDC_k, then the ratio GDP_j / GDP_k is multiplied by a negative value, and the larger (smaller) is the difference between GDP_j and GDP_k, the less (more) intra-industry trade should occur.

3) The value of GDP per capita for the reporting country (GDC_j), is used to account for the influence of the implied endowment of capital per worker. It is expected that the larger the capital labor ratio the greater the IIT_{jk}.

In common with other econometric analyses of intra-industry trade, additional explanatory variables are included in the model. First, in order to allow for the possible impact of long-run exchange rate variation between the trading countries, a variable is included that measures the absolute value of the one year proportional change in the exchange rate between the reporting and partner country, DEX_{jk}:

$$(5) \qquad DEX_{jk} = \left(\frac{|ex_{jt} - ex_{jt-1}|}{|ex_{kt} - ex_{kt-1}|} \right) \left(\frac{ex_{kt}}{ex_{jt}} \right)$$

where ex_{jt} and ex_{kt} are the dollar exchange rates for country j and k at time t. De Grauwe and de Bellefroid have examined the influence of long-run exchange rate fluctuations on the aggregate level of trade. They argue that the appropriate time-frame for studying the effects of exchange rate fluctuation on the volume of trade is at least a year, if not longer, and this is why earlier studies that employed exchange variation computed over a shorter time period have found no relationship between exchange rate variation and trade. In their study they aggregate bilateral exports for two points in time; before the era of flexible rates (1960-1969) and after the rates were freed (1973-1984). They find that the mean value of the absolute proportional change in annual exchange rates (the mean of DEX_{jk}) has a negative influence on the level of trade. Thus it can be assumed, *a priori*, that the implications for IIT_{jk} are similar. A factor that negatively influences all bilateral trade should have an equivalent impact on intra-industry trade in processed food.

Second, in order to account for the trading partners' relative location, a cubic function in the distance between geographic centers of each country is estimated. These distances were computed using spherical geometry and the latitude and longitude of the geographic center of each country as given in the SAS data set WORLDMAP (SAS Institute Inc. 1989). These values are given in radii of the earth. Given the direct relationship between transportation cost and distance we anticipate that this will have a negative impact on IIT_{jk}.

Third, dummy variables are included for trade between countries that are either both in the European Community (EC_{jk}), or both in the European Free Trade Association ($EFTA_{jk}$), and to allow for trading countries sharing a common land border ($BORDER_{jk}$). The specification also

includes dichotomous variables for each country as an exporter and as an importer to account for country-specific unobserved factors such as tariff and non-tariff barriers which are not accounted for by the variables defined above. Additional dummy variables are also included for each year in order to account for international events such as the energy price shocks and other year specific events.

3. Estimation

The variables described above were employed in a linear model using a weighted cross-section/time-series fixed-effects tobit procedure (Tobin)[7]. The weights are given by the ratio of the number of 4-digit SICs included in the aggregate value of IIT_{jk} (n_{jk}) to the average for the entire sample. The weights imply that data for those countries with the greatest number of SIC=20 industries that engage in international trade are weighted more heavily than data for countries with fewer industries involved in international trade. **Table 1** summarizes the average values of n_{jk} and IIT_{jk} over the countries from which they import (their trading partners k). Note that an industry will be included in n_{jk} if either exports or imports are observed. The range of weights is almost monotonically related to the average values for IIT_{jk}, thus the weights have a tendency to diminish the influence of countries with smaller levels of IIT_{jk}.

In previous analyses of intra-industry trade, either a logistic transformation (see Noland) or the untransformed Grubel and Lloyd index (IIT_{jk}) have been used as the dependent variable in a non-linear specification of the logistic function (Balassa and Bauwens). Unfortunately, neither of these techniques deals explicitly with the possibility of observing a large proportion

**Table 1: Average IIT_{jk} to All Trading Partners and
the Average Number of Industries where $IIT_{jkt} \geq 0$**

|	Reporting (Importing) Countries	Average Number of 4 digit SICs	Average IIT_{jk}
1	*United Kingdom*	31.2266	0.18894
2	*Germany (West)*	30.1182	0.18757
3	*Netherlands*	29.8112	0.16752
4	*United States*	29.5254	0.15683
5	*France*	28.2381	0.15470
6	*Italy*	25.6125	0.12681
7	*Denmark*	24.9869	0.13057
8	*Belgium*	24.9360	0.14765
9	*Switzerland*	23.4795	0.13931
10	*Japan*	22.6289	0.11954
11	*Canada*	22.3695	0.11675
12	*Australia*	21.7537	0.08836
13	*Sweden*	21.6371	0.11582
14	*Spain*	20.8965	0.11138
15	*Norway*	19.1872	0.09180
16	*Hong Kong*	18.5353	0.10359
17	*Singapore*	18.3744	0.08291
18	*Austria*	18.2939	0.10341
19	*Malaysia*	16.7947	0.06373
20	*Ireland*	16.4910	0.08141
21	*Greece*	16.2003	0.07093
22	*Finland*	15.1330	0.07853
23	*Israel*	15.0854	0.08429
24	*Portugal*	14.5435	0.06187
25	*New Zealand*	14.4745	0.05253
26	*Korea*	9.5435	0.05327
27	*Mexico*	9.1117	0.05717
28	*Iceland*	6.9048	0.01601
29	*Malta*	5.2791	0.01750
30	*Taiwan*	2.6700	0.03680

of country pairs with zero IIT_{jk}'s as is the case in the processed food industries. Of the 19,140 possible observations in the sample (870 trading partner combinations for 22 years), 14,204 are non-zero. Of the remainder, 4,371 are recorded as zero, which indicates that only one-way trade (either imports or exports) was present in all the food processing industries, and the other 565 have an IIT_{jk} that is undefined (no trade reported between the countries in any processed food). Furthermore, the distribution of the non-zero observations is not influenced by the upper limit of one on IIT_{jk} as can be seen in **Figure 2**.

Figure 2 is a nonparametric kernel estimate of the density of the non-zero valued $IIT_{jk}s$[8]. As can be seen from this plot, the addition of a large proportion (over 20%) of the data with zero values will result in misspecification of a model in which it is assumed that the errors are identically distributed, as would be the case with either a linear regression on the logistically transformed IIT_{jk} or a nonlinear logistic regression on the non-transformed IIT_{jk}.

The tobit model specification, as defined in Tobin, implies a data generating process defined by a censored normal distribution (See Maddala for details). The present specification assumes that IIT_{jk} is observed to lie between zero and one when an unobserved variable y (the tendency to engage in intra-industry trade) is greater than zero and that $IIT_{jk} = 0$ when $y < 0$ and that y is normally distributed. The implication that y is negative can be interpreted as a tendency for a country not to engage in intra-industry trade. Thus, the more dissimilar two countries' technologies the less the tendency to engage in intra-industry trade.

Figure 2: Density of the Index of Intra-Industry Trade

(The vertical axis is scaled so that the area under the curve is equal to 1.)

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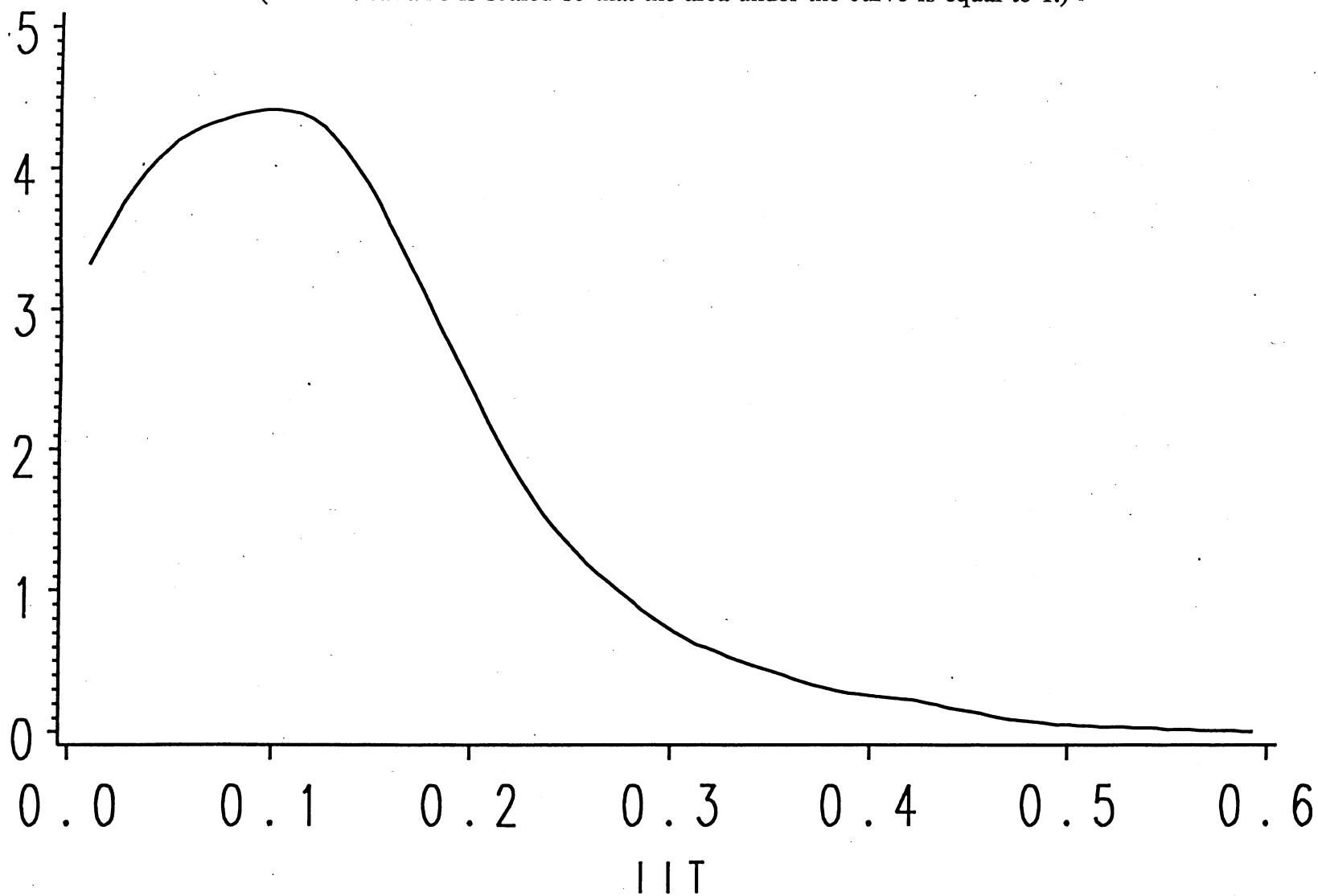
4. Results

The estimated parameters from the tobit procedure are reported in **Table 2**. Tobit parameters do not have the interpretation as derivatives of the independent variable with respect to the regressor. However, the derivative of the expected value of the dependent variable with respect to the regressor is the estimated coefficient times the value of the cumulative density function (c.d.f.) for the normal distribution evaluated at a particular value of the regressors (usually the mean)(Maddala, eq. 6.37). Because the c.d.f. is always positive, the sign of the derivative is the same as the sign of the estimated coefficients, and if the value of the c.d.f. is assumed to be independent of the parameter set, the t-tests on the coefficients are equivalent to the comparable tests on the derivatives. Although the usual R^2 statistic for a regression model is not applicable in this case, the squared correlation between the predicted and the actual values (including zeros) is .64.

The most prominent feature of the results is the support for the Helpman and Krugman hypothesis, the significant negative coefficient for the *INEQGDC* variable indicating that, the greater the inequality in GDP per capita between the trading countries, the lower the level of intra-industry trade. In addition, the positive coefficient on *GDC* indicates that the reporting country's level of GDP/capita has a positive influence on the level of IIT_{jk}. The high estimated variance of the parameter for *GDPSIZE* indicates the inability of this variable to influence the level of intra-industry trade (even when *GDC* is not included in the model this parameter is not significantly different from zero). The negative coefficient on *DEX* indicates that exchange rate uncertainty negatively influences IIT_{jk} and confirms the results that De Grauwe and de Bellefroid

Table 2: Estimated Parameters from the Weighted Tobit Procedure

	Coefficient	t-statistic
INTERCEPT	-0.08227	-8.7930
INEQGDC	-0.15131	-17.0413
GDPSIZE	0.01041	0.0834
GDC	0.30119	3.1981
DEX	-0.01172	-4.4005
DIST	-0.04804	-6.9261
DIST2	0.04474	7.7205
DIST3	-0.01080	-8.1427
BORDER	0.14600	78.7427
EC	0.07269	34.4555
EFTA	0.03939	17.3493

found for aggregate trade. The dichotomous variables for trade between countries that share a common border (*BORDER*), countries that are both members of the European Free Trade Association (*EFTA*), and countries that are both members of the European Community (*EC*), are all positive. The impact of EC membership appears to be greater than twice the impact of membership in EFTA. However, the effect of a common border appears to be greater than membership in either of these trade zone affiliations. An alternative model specification with interaction terms for *BORDER* and *EC* and *BORDER* and *EFTA* was estimated. However, it was found that these estimated parameters are not significantly different from zero and that their inclusion in the model has a negligible effect on the estimates of the *BORDER*, *EC*, and *EFTA* parameters.

Coefficients are also reported for the influence of distance, as given by (*DIST*), distance squared (*DIST2*) and distance cubed (*DIST3*). These were introduced to allow the estimation of a cubic function for the relationship of intra-industry trade to the distance between the countries. **Figure 3** provides the plot of the total effect of these coefficients at different distances along with a confidence interval of two standard deviations based on the estimated covariance matrix of the parameters[9]. The results indicate that distance initially has a negative effect on the level of intra-industry trade, then a positive followed by a negative impact. Although the shape of this relationship is dictated by the cubic specification, we find that the inclusion of a polynomial in the inverse of the distances does not change this shape in an appreciable way. This shape could be due to economies of scale in transportation over certain distances.

Figure 3: The Effect of Distance
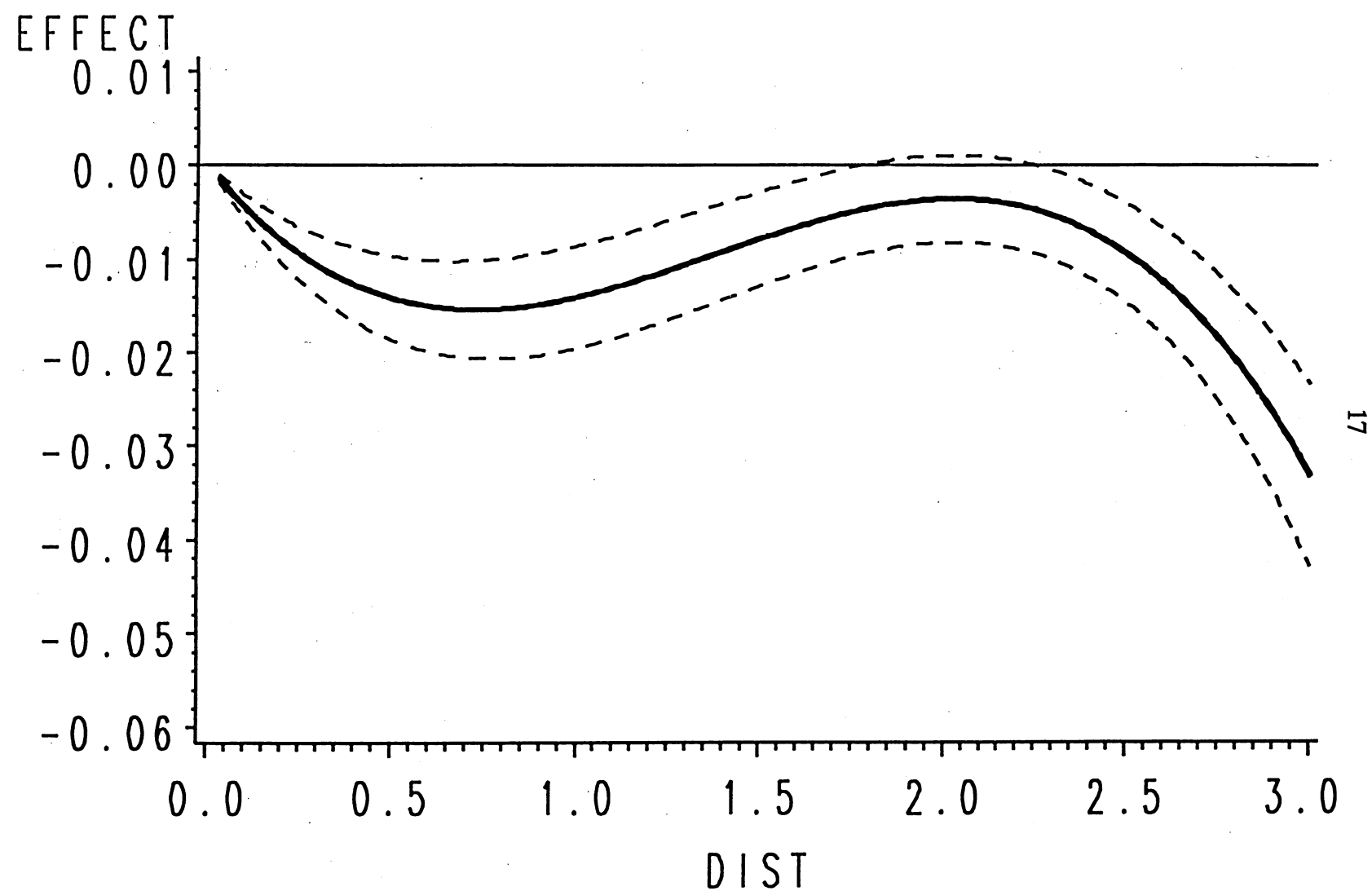
The parameters reported in **Table 2** were recomputed using a number of alternative specifications. A number of authors have used the "adjusted Grubel-Lloyd Index" which is defined as a weighted version of the IIT_{jk} where the total level of exports and imports in all sectors is used to adjust for the overall balance of trade between two countries. The adjusted IIT is defined as;

$$(6) \qquad adj(IIT_{jki}) = 1 - \frac{\mid X_{jki}/\overline{X_{jk}} - M_{jki}/\overline{M_{jk}} \mid}{X_{jki}/\overline{X_{jk}} + M_{jki}/\overline{M_{jk}}}$$

where $\overline{X_{jk}}$ is the total exports and $\overline{M_{jk}}$ is the total imports between countries j and k. The equivalent estimates for the parameters in **Table 2** computed from using these $adj(IIT_{jki})$ result in the same conclusions with no change in the signs or appreciable differences in the relative magnitudes.

An additional specification considered was the inclusion of the entire data series with the 565 observations with undefined values for IIT_{jk} (cases with neither imports nor exports) listed as zero. Because these observations had weights equal to zero, they could only be incorporated in a model with equal weights. This model also yielded results that differed in no appreciable way from the values listed in **Table 2**.

In addition to the variables based on economic and location characteristics of the trading countries, the fixed effects for countries were estimated for when they are either the reporting (importing) countries or the partner (exporting) countries. **Table 3** provides the country-specific coefficients for all countries but Taiwan, for which data were missing in numerous years and

Table 3: Fixed Effects for Reporting and Partner Countries

	Partner (Exporter)		Reporting (Importer)	
	Coefficient	t-statistic	Coefficient	t-statistic
Australia	0.13215	25.1198	0.02279	2.5984
Austria	0.11648	22.3285	0.00976	1.1525
Belgium	0.17409	34.4347	0.05947	6.7797
Canada	0.16237	31.8314	0.04460	4.4542
Denmark	0.15255	29.8423	0.03955	4.2727
Finland	0.09627	17.9688	-0.00877	-1.0173
France	0.16373	32.7603	0.04890	5.4723
Germany	0.19789	40.0067	0.07943	8.8241
Greece	0.11022	21.5573	0.01591	2.1368
Hong Kong	0.15630	30.3538	0.05475	6.9817
Iceland	-0.00843	-1.4153	-0.10809	-11.1809
Ireland	0.10723	20.4784	0.00820	1.0796
Israel	0.12538	22.5432	0.02375	2.9669
Italy	0.14125	27.7097	0.03566	4.4893
Japan	0.16550	32.6706	0.05747	6.9837
Korea	0.11311	20.1530	0.03013	3.8248
Malaysia	0.11663	22.7498	0.02756	3.7245
Malta	-0.00018	-0.0277	-0.08107	-9.0335
Mexico	0.07595	13.5774	-0.00751	-0.9554
Netherlands	0.19836	39.0497	0.08137	9.3004
New Zealand	0.09115	17.0603	-0.01335	-1.5591
Norway	0.12320	21.8973	0.01252	1.2855
Portugal	0.09683	18.7846	0.00559	0.7501
Singapore	0.13177	25.6508	0.03008	3.9388
Spain	0.14467	27.8228	0.04292	5.5098
Sweden	0.14801	28.8805	0.03476	3.8827
Switzerland	0.15947	31.7836	0.04496	4.6688
Taiwan	--	--	--	--
United Kingdom	0.22665	45.7908	0.10822	12.9306
United States	0.19828	40.1197	0.08313	8.0676

whose influence is included in the intercept term. It should be noted that these coefficients explain a portion of the shift in IIT_{jk} that is not explained by the other explanatory variables, and thus they indicate how well the economic terms explain the trade that is occurring. It can be seen from this table that, except for Iceland and Malta, all the countries listed have either a positive or non-significant impact on intra-industry trade if they are the importer. Also, again except for Iceland and Malta, these same countries have the lowest values for the variable that identifies them as exporters, although neither of these coefficients are significantly negative. It can also be seen that the United Kingdom, the United States, Germany (West Germany), and the Netherlands are the positive outliers both as importers and exporters. These terms indicate the influence of other factors not included in the specification that are correlated with the equality of GDP per capita ($INEQGDC_{jk}$) and GDP per capita (GDC_j).

As well as the country-level fixed effects, a set of year-specific, dichotomous variables was also introduced to capture any secular trends or time-related international events that might influence the level of intra-industry trade (1968 is included in the intercept due to observed data anomalies). These coefficient estimates are plotted in **Figure 4** as a time-series with an upper and lower bound defined as two standard deviations above and below the estimate. This figure indicates that, aside from the apparent data lapses in 1968 which is included in the intercept, there has been a general increase in intra-industry trade, although there was a definite drop during the 1973 and the 1978 oil price shocks[10].

Figure 4: The Year-Specific Fixed Effects
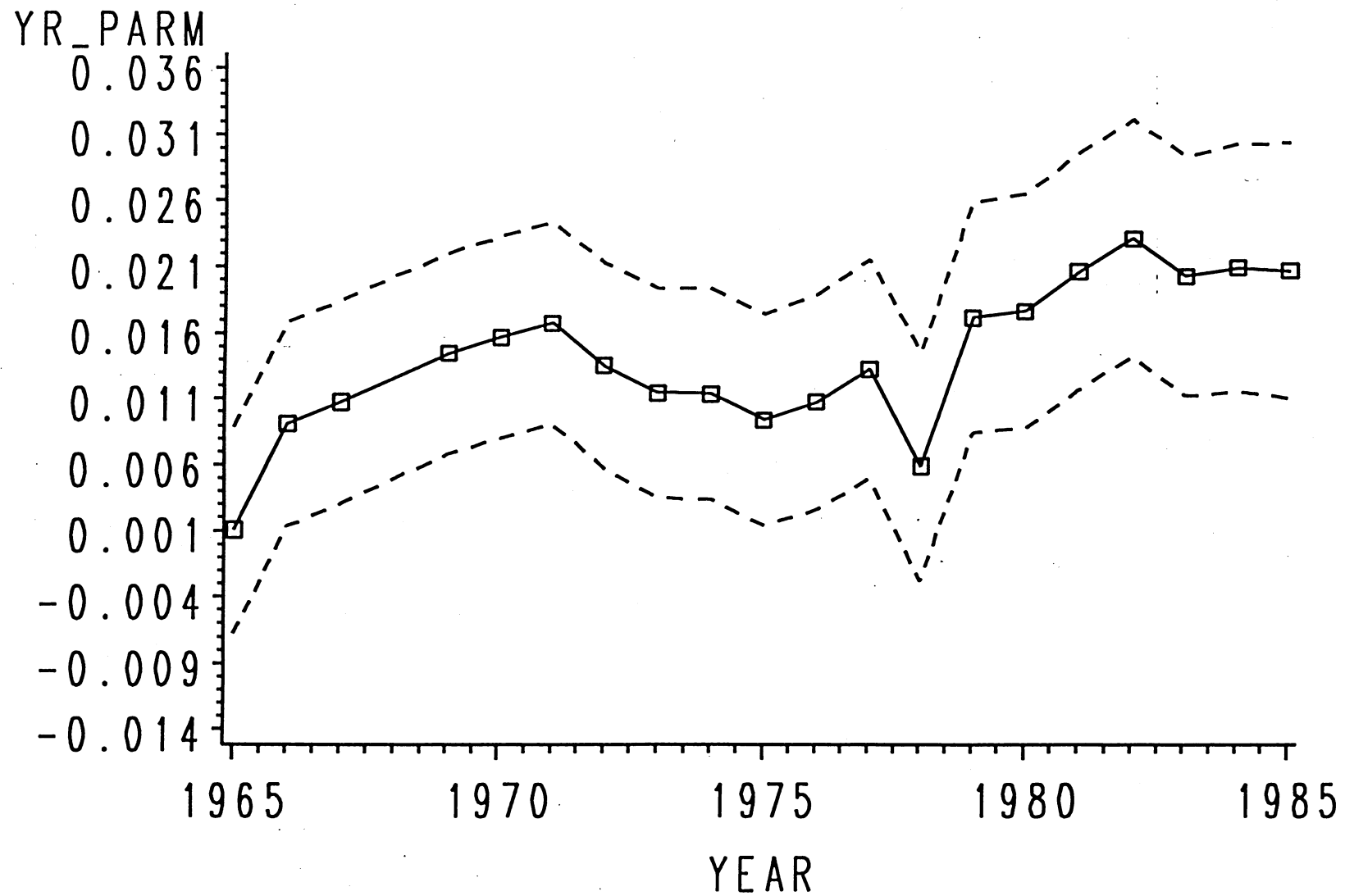
5. Summary

The growth in international trade in the post-war period has been dominated by the increasing share of intra-industry trade, a feature that has also characterized trade in processed food products. In this context, this paper has focussed on analyzing the factors that influence bilateral intra-industry trade in the food processing sector for a sample of 30 countries over the period 1964-1985. Following Helpman and Krugman's 2 X 2 X 2 model of trade, three hypotheses concerning the impact on trade of countries' relative factor endowments and relative size have been tested in a pooled cross-section/time-series analysis using a weighted, fixed effects tobit procedure. It is important to note that the procedure, in combination with a cross-section/time-series, has not been used in previous studies of intra-industry trade. In addition, the food processing sector has never been analyzed in this manner.

The results of the analysis provide strong support for two predictions of the Helpman and Krugman model, indicating that intra-industry trade is a positive function of a country's GDP per capita and the equality of GDP per capita between countries. It was also found that membership in either a customs union or a free trade area has a positive effect on intra-industry trade between countries, as does a common border, while confirming other research which has shown that long-run exchange rate variation tends to lessen trade. In addition, the overall impact of distance between countries has a negative effect on intra-industry trade, however this effect becomes less pronounced at certain distances, which may be a sign of economies of scale in transportation over some distances.

Footnotes

1. This draws on earlier work by Krugman (1979, 1981), Dixit and Norman, and Helpman.

2. The assumed demand structure for differentiated goods follows that of Dixit and Stiglitz, whereby consumers derive utility from variety and consume some portion of all available varieties. See also Krugman (1979, 1981).

3. See Helpman and Krugman for the precise specification for determining the number of varieties n.

4. Helpman and Krugman show for any country j that, $GDP_j = \pi(p, L_j, K_j)$, where π, p, L_j and k_j are profits, prices, labor and capital respectively. Re-arranging gives, $GDP_j / L_j = \pi(p, K_j / L_j)$, (see pp.171-172).

5. Support for this hypothesis can be found in Havrylyshyn and Civan.

6. This is defined as SICs 2011-2099, using a concordance between SIC and SITC definitions suggested by Dayton and Henderson.

7. The estimation was done using the LIFEREG program in the SAS system (see SAS 1989 for details).

8. This figure was constructed using an Epanechnikov kernel (See Silverman) and the band width as proposed by Scott. Note that the vertical axis of this figure is the value of the probability density function (p.d.f.). The values of the p.d.f. are scaled so that its integral over the range of IIT_{jk} is equal to one.

9. The distance is measured in terms of the radius of the earth (approximately 4,000 miles) thus the largest distance is 2π radii. In the data at hand, the distribution of intra-country distances has modes at .3 and 1.5 radii indicating intra-continental and inter-continental trade. The average distance is 1.03, although almost no countries are this distance apart.

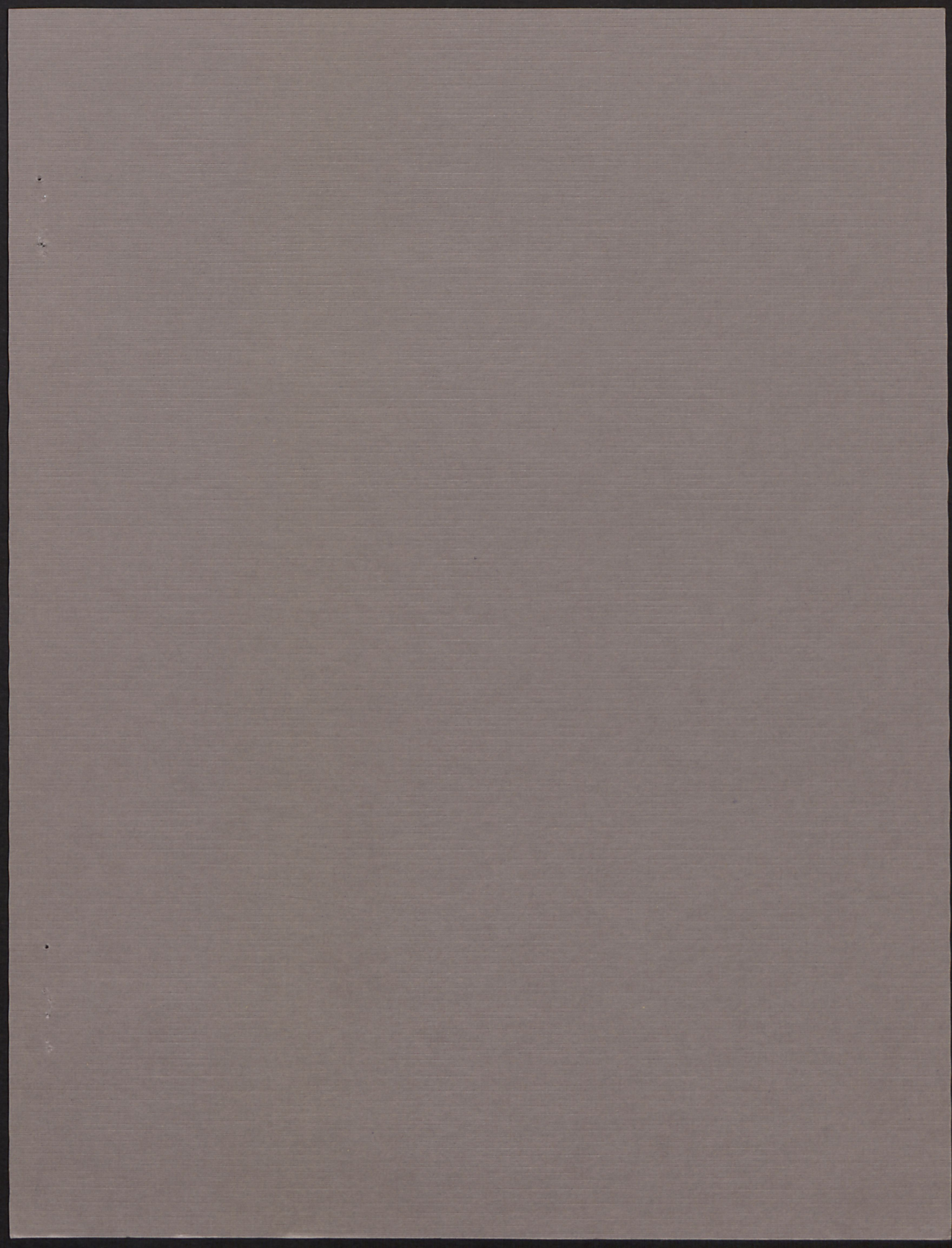10. The drop recorded for 1978 may also due to a data problem similar to the 1968 data.

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