A Cross-Section Analysis of Intra-Industry Trade in the U.S. Processed Food and Beverage Sectors

Darcy A. Hartman, Dennis R. Henderson, and Ian M. Sheldon

This paper analyzes the determinants of variation across industries in levels of intra-industry trade (IIT) for a sample of thirty-six U.S. processed food and beverage industries in 1987, previous studies of intra-industry trade having focussed on industry characteristics in the manufacturing sectors. The determinants predicted by IIT theory are measures of product differentiation, economies of scale, and imperfect competition; the results of this analysis indicate that IIT variation across the food and beverage industries is positively related to product differentiation, economies of scope, and similarity of tariff barriers among trade partners, but negatively related to industry concentration.

Introduction

Intra-industry trade (IIT), which is defined as the concurrent importation and exportation of similar goods (Greenaway and Milner, 1986a), has become an increasingly important phenomenon in international trade. IIT was first observed in empirical work on the evolution of the European Community (EC) by Verdoorn, and Balassa (1965), and since then an extensive literature has shown evidence of IIT in the trade of developed economies (e.g. Grubel and Lloyd; Aquino; and Greenaway and Milner, 1984), less developed countries (e.g. Balassa, 1979; Havrylyshyn and Civan) and centrally planned economies (e.g. Drabek and Greenaway).

In developed countries such as the U.S., UK and Canada, average levels of IIT in the manufacturing sector, as measured by the Grubel and Lloyd index at the three-digit level of the SITC (see Section 1 for a discussion of the index), rose from 0.44, 0.47 and 0.28 respectively in the early 1960s to 0.64, 0.72, and 0.73 respectively in the early 1980s (Greenaway and Milner, 1986b; Hart and McDonald). Also, while it tends to be lower than in the developed countries, IIT has also grown in the developing countries, for example, the average level of IIT in manufacturing grew in Mexico from 0.12 in 1962 to 0.42 in 1987 (Hart and McDonald). Therefore, IIT is a phenomenon of growing importance in the structure of international trade, and one that is both challenging to theorists to explain and researchers to measure, and of relevance to policymakers. These aspects will be examined in the subsequent sections.

(i) Theory of Intra-Industry Trade

Traditional trade theory, which predicts countries will specialize in the production and export of goods that use their abundant resources and import goods that use their scarce resources, cannot rationalize the existence of IIT. In recent years, a substantial theoretical literature has emerged that attempts to explain IIT (see Helpman and Krugman, 1985; Greenaway and Milner, 1986a; and Sheldon for surveys). These theoretical developments have predominantly emphasized the existence of imperfect market structures, economies of scale, and product differentiation as the major factors determining IIT. Perhaps the best known and most general models are those based on a structure of monopolistic competition, the major contributions having been synthesized by Helpman and Krugman (1985), based on the earlier work of Krugman (1979, 1980, 1981), Lancaster, and Helpman (1981).

Essentially, in this type of model, countries are assumed to share the same technology, such that in

---

The authors, respectively, are Research Associate, Professor, and Associate Professor, Department of Agricultural Economics and Rural Sociology, The Ohio State University.

The paper is based on research conducted as part of North Central Region research project NC-194 entitled, "The Organization and Performance of World Food Systems: Implications for U.S. Policies". The authors would like to thank two anonymous referees for their helpful comments on an earlier version of this paper.

each economy, a perfectly competitive sector produces a homogeneous good under constant returns to scale, and a second sector produces differentiated products under increasing returns. Product differentiation is modelled upon the premise that consumers in aggregate have a demand for variety, which has been characterized in either of two ways. For example, in Krugman's work, the Spence-Dixit and Stiglitz approach to product differentiation is adopted whereby it is assumed that consumers derive utility from variety *per se,* and so consume some part of all differentiated goods being offered by a particular industry. Hence, there is aggregate demand for variety, product differentiation taking the form of producing a variety not yet in supply. Alternatively, Lancaster, and Helpman (1981) deal with demand for differentiated goods in the spirit of Hotelling's analysis of spatial location. Essentially, both approaches generate the same result.

Given the structure of demand, these models also assume that there is free entry by firms into the market. This generates a structure of monopolistic competition in equilibrium, while increasing returns limits the number of differentiated goods that can be produced and consumed in one country under autarky. Therefore, if trade can take place, and countries have similar factor endowments, each will produce its own supply of the homogeneous good; whereas, in the differentiated goods sector, economies of scale will ensure that production of any product will be concentrated in either one country or the other. Assuming countries' economies are the same in terms of size, then the structure of trade will be pure IIT, where each country produces, consumes and exports part of the range of differentiated products and imports the rest from the other country(ies).

It should also be noted that, once the differentiated goods sector is assumed to have a capital-intensive production technology, and differing factor endowments are allowed for, in the extreme, inter-industry trade will be observed, whereby the capital-endowed country specializes in the production and export of differentiated products. Hence, Helpman and Krugman's (1985) synthesis can be regarded as a proper generalization of the Heckscher-Ohlin model, such that the theory can predict that IIT will occur where there is product differentiation, economies of scale and market structures that are less than perfectly competitive. In addition, IIT is more likely to occur between countries with similar factor endowments, a prediction supported in recent empirical work by Helpman (1987) on aggregate trade patterns for fourteen industrial countries over the period 1970–1981.

Although there are other models of IIT (e.g. Brander and Krugman's model of reciprocal dumping, based on duopoly; and Falvey's analysis based on perfect competition and external economies of scale), the analysis outlined above is generally regarded as being the most thorough approach and, as Helpman and Krugman (1989) have recently commented, ". . . the positive theory of trade under imperfect competition has now reached a certain maturity and acceptance." (p. 2).

While the analysis of the causes of IIT has grown in the past fifteen years, it is only recently that the policy implications have been examined in depth. The literature here addresses two interrelated aspects. First, there is the issue of the welfare gains from trade liberalization in the presence of IIT. The analysis outlined above indicates that there are likely to be gains from trade over and above those of exchange and specialization in the traditional model. Specialization in situations where economies of scale exist will generate production gains, depending on the specification of the cost function; if trade widens consumer choice, there are gains from exchange; and the opening up of imperfectly competitive domestic markets to imports may yield further gains.[1] All of these points have been substantiated in recent empirical work (see Richardson, 1989, for a survey). For example, Cox and Harris have shown in their evaluation of the U.S./Canada free trade agreement that the presence of economies of scale generates considerably larger welfare gains than those predicted by neoclassical trade theory. Similar analysis by Smith and Venables of the move to greater economic integration in the European Community (EC) indicates that in a framework of product differentiation and economies of scale, the gains from removing trade barriers are much larger than those normally associated with conventional customs union analysis.

Second, it has been suggested that if trade is of an intra-industry nature, then industrial adjustment to competitive forces will be easier than if trade were of an inter-industry nature (see Greenaway and Milner, 1986a). Although there have been few empirical studies to support this contention, the basis for it is that if industries are characterized by product differentiation, then it is easier to adjust product lines than it is to undertake the industrial restructuring implied by inter-industry trade. This suggests that either multilateral or bilateral trade

[1] As Helpman and Krugman (1985, Ch. 7) note, these gains cannot be guaranteed in general as imperfect competition does not result in an optimum.

liberalization will generate fewer distributional changes than in the traditional model (see Krugman, 1981), a factor which is important for policymakers to recognize.

(ii) Empirical Analysis of Intra-Industry Trade

Along with the theoretical analysis, there have been several econometric studies of the determinants of IIT (see Greenaway and Milner, 1986a; and Sheldon for surveys). Most of the empirical work, the present study included, has set out to estimate a simple, reduced-form regression model where the dependent variable is an index of IIT for industry i at time t, and the explanatory variables are a vector of either industry and/or country characteristics based on the theory outlined. Most studies estimate this type of regression over a cross-section of industries using either bilateral or multilateral trade data, while some studies, notably Balassa and Bauwens, have adopted a multi-industry, multi-country framework.

As researchers in this field acknowledge (Greenaway and Milner, 1986b), the econometric analysis of IIT is difficult, both from a methodological and a practical viewpoint.[2] Because there is no completely general model of IIT, it has not been possible to set up general hypothesis tests as has been the case with the Heckscher-Ohlin model, nor has it been possible to devise means of discriminating between competing hypotheses concerning market structure. Consequently, most researchers have resorted to ". . . 'identifying' (using regression techniques) the cross-sectional characteristics of their data sets, i.e. to describing a range of sources of influence on IIT that are suggested by, or consistent with, the various models of IIT." (Greenaway and Milner, 1986b, p. 5). In addition, as many of the crucial explanatory variables, such as product differentiation, are notoriously difficult to measure, researchers have had to rely on the use of proxy variables.

However, notwithstanding these problems, the results of this econometric analysis indicate fairly robust and consistent support for the theory as laid out earlier; proxy variables for market structure, product differentiation and economies of scale do have some explanatory power along with other control variables such as tariffs (see Greenaway and Milner, 1986a).

(iii) Intra-Industry Trade and the Food Industry

A distinguishing feature of this paper is that the focus is on one sector, the processed food and beverage industry, as opposed to a broader cross-section of industries in the manufacturing sector. Also, until recently, most studies have, by and large, ignored the processed food and beverage industries. This is due, in part, to a perception that the food and beverage industries are perfectly competitive. On the contrary, there is evidence that the food and beverage industries exhibit various imperfect market structures and produce heterogeneous goods. (For a thorough discussion of the food and beverage industries, see Connor, *et al.*, and Sutton). In addition, IIT has been documented in the processed food and beverage industries (McCorriston and Sheldon; Christodoulou; Hart and McDonald; Hirschberg, *et al.*). For example, McCorriston and Sheldon indicate that in 1986, the EC exhibited a higher level of IIT than the U.S. across a sample of food processing industries, largely as a result of the volume of intra-EC trade. While Hirschberg, *et al.*, in analyzing the determinants of IIT in food processing for a thirty country sample over the period 1964–1985 found that it was a growing phenomenon in this sector and was a positive function of a country's GDP per capita and equality of GDP per capita between countries, thus providing strong support for some of the predictions of the Helpman and Krugman (1985) model.

As gains from trade in the form of greater product variety, increased realization of economies of scale, and increased competition are predicted by the theories of IIT, *a priori*, it would seem important to measure the extent of IIT in the U.S. processed food and beverage industries, and to examine its causes in these industries using the type of regression methodology outlined above. While Hirschberg, *et al.*, have studied the extent to which country characteristics explain the level of IIT in these industries over time, this study focuses on characteristics that affect the level of IIT across industries for a specific point in time for the U.S.

The rest of the paper is organized as follows: in Section 1, the levels of IIT for the various food and beverage industries are calculated and discussed.

---

[2] This type of empirical work has recently been subject to criticism by Learner. Generally he argues that the linkage of the theory of IIT to the empirical analyses is rather casual, and is based on combining the results of several different theories in a single regression model. However, this econometric work is still really in its early stages, and the only empirical work that has incorporated the type of utility function described earlier, along with economies of scale and imperfect competition, has been the computable partial equilibrium work of Venables and Smith, and Smith and Venables. In addition, if Schmalensee's position on inter-industry studies of structure and performance is adopted, it can be argued that while such studies cannot yield consistent estimates of structural parameters, they can uncover ". . . stable, robust, empirical regularities . . ." (p. 1000), and while there are data problems in this type of analysis, they are not ". . . so severe as to render cross-section work valueless . . ." (p. 952).

Section 2 develops a simple regression model of the industry characteristics of IIT based on the theory already outlined and empirical studies for other industries, while in Section 3, the results of cross-section analysis are discussed. Some concluding comments are made in Section 4.

1. Measurement of IIT

In this study, the Grubel and Lloyd index (GL) is used to measure IIT in the U.S. processed food and beverage sectors (Grubel and Lloyd). A review of previous studies reveals that GL has been the predominant measure used, examples being Toh, Greenaway and Milner (1984), and Balassa and Bauwens. The GL index measures the absolute value of industry i's exports offset by industry i's imports, expressed as a proportion of that industry's total trade:

$$(1)\quad GL_i = \frac{(X_i + M_i) - |X_i - M_i|}{(X_i + M_i)}$$

$$0 \leq GL_i \leq 1.$$

GL_i corresponds directly to the level of IIT. When no trade overlap exists, GL_i equals zero. If there is complete overlap, GL_i equals unity. (See Greenaway and Milner, 1986a, for a review of the measure.)

Herein, measurement of GL_i is based on the United Nations (UN) D-Series Trade Data, where, in order to match this data with industry data reported in SIC's, the SITC codes were converted to four-digit SIC codes using a concordance developed by Dayton and Henderson. The industry codes for the food and beverage industries range from SIC 2011 to 2099; Table 1 contains code descriptions.[3] The four-digit classification was used because it was necessary to minimize the possibility of categorical aggregation, which is the inappropriate grouping of trade categories for the purposes at hand, by disaggregating as much as possible; however, the data used for measuring industry variables could not be disaggregated beyond the four-digit level for most independent variables.

The measurement of GL_i is based on total U.S. trade with a group of thirty countries. These thirty countries were chosen due to their consistency in reporting of trade data. In addition, they constitute 92% of total world trade in processed food and beverage products. The data were taken from the reports of the importing countries. Import data are generally accepted as more accurate than export data since countries tend to be more concerned with imports for such purposes as the collection of duties, etc., and since transshipments are not included.

The estimates of GL_i for the food and beverage industries in 1987 are reported in Table 1; 1987 was chosen as it is the most recent year for which Census of Manufactures data are available. The estimates of GL_i have a sample mean of 0.329 with a variance of 0.095. The distribution is as follows: 4 categories have IIT levels of 0.80–1.00, 3 categories have IIT levels of 0.60–0.79, 5 categories have IIT levels of 0.40–0.59, 8 categories have IIT levels of 0.20–0.39, while 16 categories have IIT levels of 0.00–0.19. The industries with almost complete overlap are meat packing (2011), butter (2021), breakfast cereals, and other (2099). While a large percentage of categories (44%) show almost no IIT, the majority do have substantial trade overlap. These results reinforce other evidence for the existence of IIT in the food and beverage industries.

2. Determinants of Inter-Industry Variation of Intra-Industry Trade

In choosing determinants of IIT to be tested, some obvious choices are those factors presented in the theoretical work on IIT which was outlined in the section above, i.e., *a priori,* the level of IIT in an industry will be related to product differentiation, the existence of economies of scale, and imperfect competition. Beyond that, reviewing previous empirical work in the field yields some additional suggestions. The variables described below are those that were used in the final analysis. Other variables suggested by the theory and earlier empirical work were tested in preliminary analysis and were discarded due to being consistently insignificant; these will be mentioned briefly at the end of this section.

(i) Product Differentiation: As suggested in the opening section on the theory of IIT, product differentiation is considered by most researchers to be one of the key determinants of IIT. In addition, empirical support for this hypothesis has been found in several previous econometric studies,

[3] As one of the referees pointed out, the sample of SICs used in the analysis omits certain industries such as, ice cream and frozen desserts (2024), prepared flour mixes and doughs (2045), and others in the SIC. This follows from the fact that the SITC codes do not precisely match the SIC codes, hence several SIC codes have no equivalent SITC code, and therefore have to be excluded from the sample. In addition, matching SIC with SITC codes is never completely precise, and so another researcher's concordance might produce different values for IIT to those shown in Table 1. A copy of the concordance between SITC and SIC codes used by the authors is available on request.

Table 1. U.S. Trade Figures, 1987 ($000)

SIC	Description	M_i	X_i	GL_i
2011	Meat Packing	2563884	1970440	0.869
2013	Sausages	50239	359088	0.245
2015	Poultry & Eggs	238969	4718	0.039
2021	Butter	3822	3845	0.997
2022	Cheese	23117	375309	0.116
2023	Canned Milk Products	606	20010	0.059
2026	Fluid Milk	2719	4179	0.788
2032	Canned Foods	11860	31182	0.551
2033	Canned Fruits & Vegetables	177169	551735	0.486
2034	Dehydrated Food	463138	90427	0.327
2035	Pickles, Sauces, etc.	0	50865	0.000
2037	Frozen Fruits & Vegetables	101156	163469	0.765
2041	Grain Mill Products	283205	13874	0.093
2043	Breakfast Cereals	27078	23639	0.932
2044	Milled Rice	142923	707	0.010
2046	Corn Milling	681896	6405	0.019
2048	Feed Products	273483	91855	0.503
2051	Bread & Pastries	0	316118	0.000
2063	Beet Sugar	1525	8	0.010
2066	Chocolate Products	83772	388613	0.355
2068	Nuts & Seeds	661881	121099	0.309
2074	Cottonseed Oil	17859	3454	0.324
2075	Soybean Oil	726069	41819	0.109
2076	Vegetable Oil	45033	235146	0.321
2077	Animal Oil	324896	39257	0.216
2079	Shortening, Margarine	108900	33582	0.471
2082	Beer	41249	865919	0.091
2084	Wine	49985	940121	0.101
2085	Liquor	101318	1289661	0.146
2086	Soft Drinks	268	56269	0.009
2091	Canned, Cured Fish	240084	474539	0.672
2092	Frozen Fish	1318866	3144408	0.591
2095	Roasted Coffee	81298	706226	0.206
2097	Ice	0	44248	0.000
2098	Pasta	5826	68337	0.157
2099	Other	284075	317273	0.945

X_i = exports of industry i, M_i = imports of industry i, GL_i = Grubel and Lloyd index for industry i.

e.g., Pagoulatos and Sorenson, Greenaway and Milner (1984), and Balassa and Bauwens. While the theoretical work on IIT indicates that a structural model would require the estimation of a specific utility function in order to model the demand for variety, this has proved difficult to do empirically. Hence, this study follows previous empirical work on IIT by constructing a proxy index of product differentiation. Specifically, in this study, the advertising/sales ratio (AS) was used to characterize the degree of product differentiation[4]; this measure is commonly used for this purpose in industrial organization research, and has been adopted in previous empirical work on IIT by Caves, Greenaway and Milner (1984), Tharakan, and Balassa (1986). *A priori,* the more money spent on advertising in an industry, the more differentiated are the products in that industry, and, hence, the greater the likelihood of IIT.[5] The advertising data were taken from the Food Marketing Review, and sales data were taken from the U.S. Census of Manufactures. The major problem with the data for this measure is that the advertising data were not reported by SIC codes so that there may be some errors in matching the advertising and sales data.

(ii) Concentration: Most of the theoretical research on IIT indicates a role for market structure in understanding IIT. However, as with product

[4] An alternative measure for product differentiation, the Hufbauer index, was tested but found to be insignificant. While this measure has been used in several previous studies (e.g. Toh; and Balassa and Bauwens), it has been criticized for measuring technological differentiation or differences in inputs.

[5] In the Spence-Dixit and Stiglitz approach to product differentiation, firms make fixed, recurrent outlays on advertising in order to establish a variety in the market.

differentiation, this tends to be quite difficult to capture in empirical work, in particular discriminating between competing models based on differing market structures. Nevertheless, several empirical studies have used an index of market structure, such as seller concentration, as an explanatory variable in analyzing IIT, various theories being put forward to support inclusion of such a variable. First, if economies of scale exist in an industry, the number of firms in the industry is limited, which means that concentration in that industry is likely to be relatively high. It is generally believed that if concentration is high, there is a lack of product variety; lack of product variety leads to product standardization in the industry, so IIT should be inversely related to concentration (see Krugman, 1979; Lancaster, 1980; Helpman, 1981). Empirical support for this comes from Toh, Balassa (1986), and Balassa and Bauwens.

It has also been argued that concentration, as an indicator of market power, may be associated with reduced emphasis on either exports or imports, which would result in lower levels of IIT (Glejser, Jacquemin and Petit; Lyons). Market power may limit exports as profits earned on home market sales act as a disincentive to expending effort on foreign sales. To the extent that market power results from entry barriers, such barriers may discourage imports; to the extent that market power is associated with collusion, home firms may cooperate to produce at a level that prevents new firms from entering, thus limiting imports. Alternatively, as discussed by Brander and Krugman, Toh, and Fung, if high concentration is indicative of oligopolistic market structures, there may be reciprocal dumping by home and foreign firms, which would generate observed IIT. In an effort to prevent new firms from entering, oligopolists will create a surplus in the home market and dispose of this surplus by dumping it on the foreign market. This being the case, IIT would be positively related to concentration. In order to measure seller concentration in the U.S. food and beverage industries, the Herfindahl index (HI) was used, the data coming directly from the Census of Manufactures. HI is measured by squaring the market share for each of the top fifty companies in an industry and summing.

(iii) Economies of Scope: Caves has analyzed the possible impact of economies of scope on IIT. Economies of scope occur when a firm's average costs fall if it produces more than one product. Thus, IIT could increase as joint production possibilities increase because firms trade similar products. In addition, following the literature on multiproduct cost functions (e.g. Baumol *et al.*), economies of scope can have similar effects on market structure to those of economies of scale, i.e. with economies of scope, only limited numbers of firms are required to produce a range of varieties thus limiting the number of producers in an industry under autarky.[6] It should be noted, however, that Caves found no empirical evidence to support this hypothesis.

For this study, a variation of Caves' measure was used. Specialization (SP_i) equals the ratio of the shipment of primary products of industry i made by plants classified in that industry to total shipments by those plants; this ratio is reported in the U.S. Census of Manufactures. It is hypothesized that IIT in the U.S. food and beverage sectors is positively related to $(1\text{-}SP_i) = PS_i$. PS_i is the ratio of the shipment of products of other industries made by plants classified in a specific industry to total shipments by those plants.

(iv) Similarity of Tariff Rates: As well as the above variables, which are based on the theory of IIT, most empirical studies incorporate institutional-type variables. In particular, it is generally hypothesized that IIT decreases with an increase in tariff rate dispersion, which is the difference between domestic and foreign tariff rates. Specifically, it is argued that high relative tariffs in one country(ies) are a deterrent to IIT, whereas similar tariffs on similar products are less of a deterrent to IIT, as long as the tariffs are not prohibitive. Although no consistently strong indication of a positive or negative effect of tariffs has been found in previous studies, e.g., Caves, Toh, Balassa and Bauwens, Hirschberg *et al.*, and Pagoulatos and Sorenson did find support for this hypothesis. Given the level of protection for the food and beverage sectors, it was felt that some form of tariff dispersion measurement was needed as a control variable in the analysis.

Unfortunately, comprehensive tariff data are sparse, and recent rates were simply unobtainable for foreign countries, the measure ultimately used being based on two sets of data.[7] The first comes from the U.S. International Trade Commission's Publication 737, which contains measures of U.S. and foreign trade-weighted tariff averages for 1970. The second also comes from the International Trade Commission and consists of collected duties divided by the cost of imports including insurance and freight (c.i.f.). The measures were

[6] Smith and Venables have explicitly incorporated both scale and scope economies in their analysis of EC integration.

[7] While tariff data exists for broadly defined agricultural commodities, data are not available in the necessary SIC classification for the food and beverage sector in foreign countries.

based on information coded by SIC. To calculate a foreign weighted tariff for 1987, the difference between the U.S. tariff rates for 1987 and 1970 was determined for each SIC code; these changes were then assumed to be the same in percentage terms for the foreign weighted tariff rates based on the rationale that GATT negotiations in the past fifteen years have tended to involve mutual reductions in tariffs.

The measure of similarity of tariff barriers (S) used in the following:

$$(2) \quad S_i = \frac{T_i^{US} + T_i^{FOR} - |T_i^{US} - T_i^{FOR}|}{(T_i^{US} + T_i^{FOR})}$$

$$0 \leq S_i \leq 1$$

where the superscript US refers to U.S. tariffs and FOR to foreign tariffs in industry i. The greater the degree of tariff dispersion between U.S. and foreign tariffs, the closer S_i will be to zero. *A priori,* IIT should be positively related to S_i, as it would be an indication that countries with similar tariff rates are protecting similar industries; hence, IIT would be likely to occur among these countries.

(v) Other Variables: As stated in the introduction to this section, other independent variables were tested in preliminary analyses but were found consistently to be insignificant. First, a strong departure from the theory outlined earlier was the insignificance of economies of scale as measured by minimum efficient scale (MES). However, given the small variation of MES among these industries, its insignificance was not surprising.

Second, two variables were tested to determine if IIT could be considered primarily a statistical phenomenon. The first, categorical aggregation, was a measure of the number of five-digit SIC categories within each four-digit category. The second, seasonality, was a dummy variable attempting to capture the possibility of inter-seasonal trade within an industry, which could be misinterpreted as IIT. Both were insignificant, which gives additional support for the existence of IIT in those industries.

Third, a measure of the degree of integration of an industry into the global economy was used, defined as the ratio of the sum of exports and imports in industry i, normalized by domestic production in industry i.[8] The expectation for this variable was that as the index increases, it indicates greater international integration for the relevant industry and, hence, the greater the likelihood that IIT will exist in that industry. However, the estimated coefficient on this variable proved statistically insignificant.

3. Empirical Methodology and Results

(i) Estimated Model: The model in the following analysis was estimated using ordinary least squares (OLS) based on linear specifications for a cross-section of thirty-six U.S. processed food and beverage industries in 1987. Other studies have utilized variations of OLS such as tobit (Hirschberg, *et al.*) and logit (Caves). Tobit was used by Hirschberg, *et al.*, because several of the observations for the dependent variable had zero values; the study herein also has zero values for the dependent variable, but a preliminary test using tobit did not offer results significantly different from OLS. Logit was used by Caves on the basis that, since the dependent variable may be doubly truncated (i.e., upper and lower bounds of 1,0), regression analysis needs to restrict the dependent variable so that the predicted value would adhere to the double truncation; however, there are no values at the upper limit in this sample.

Ultimately, the equation tested was:

$$GL_i = \alpha_0 + \alpha_1 AS_i + \alpha_2 HI_i + \alpha_3 PS_i + \alpha_4 S_i + \mu_i \quad (3)$$

where all variables are defined as above, the expected signs of the estimated coefficients are: α_1, α_3, $\alpha_4 > 0$; $\alpha_2 >$ or < 0; and μ_i is the error term.

(ii) Results: Table 2 reports the results of the OLS regression analysis adjusted for heteroskedasticity.[9] The model was significant at the 95% confidence level. Approximately 26% of IIT is explained by the determinants included.

Several comments can be made about the results. First, the estimated coefficient of the advertising/sales ratio (AS) was positive as expected, and significant at the 95% confidence level. This indicates that product differentiation does influence the amount of IIT in the U.S. food and beverage sectors. One important note, however, is that this variable is heavily influenced by the breakfast cereals industry which has by far the highest AS ratio and has a GL measurement of 0.932, almost pure IIT. In fact, when this observation is dropped, AS becomes insignificant; all other independent

[8] This index was suggested to us by one of the referees as an alternative to the simple sum of exports and imports which we had used in an earlier version of the paper. The latter variable proved statistically significant, but this may have been due to the fact that the same variable is included in the denominator of the dependent variable GL_i.

[9] No multicollinearity was found for this set of independent variables.

Table 2. OLS Results

Variable	Estimated Coefficient	t-ratio	R^2	Adjusted R^2	F
Advertising/Sales	3.3421	1.9025‡	0.3462	0.2619	4.104‡
Herfindahl Index	$-0.17165\ 10^{-3}$	−2.8017*			
Economies of Scope	$0.18642\ 10^{-1}$	2.1660‡			
Tariff Similarity	0.21253	1.9473‡			

‡Significant at the 95% level.
*Significant at the 99% level.

variables are unaffected by the removal of this observation. Second, the estimated coefficient of the Herfindahl index (HI) was negative and significant at the 99% confidence level. While this could be interpreted in terms of scale economies or product standardization, the lack of statistical significance associated with MES and the undeniable influence of one observation on the significance of AS lends credence to the alternative interpretation based on market power, i.e., market power discourages IIT. Third, the estimated coefficient of economies of scope (PS) was significant at the 95% confidence level, and was positive as predicted. If industries have the ability to produce multiple, differentiated goods due to economies of scope, IIT will likely occur. Fourth, the estimated coefficient of the similarity of tariff barriers (S) was positive as predicted, and significant at the 95% confidence level. If IIT exists in industries where the U.S. and its trading partners have similar tariffs, it is an indication that these countries are protecting similar industries and are likely to have similar tastes encouraging the existence of these industries.

4. Summary and Conclusions

A large body of research in international trade has uncovered simultaneous imports and exports of similar goods. While previous empirical studies of IIT have focused on manufactures, few studies have concentrated on the U.S. processed food and beverage sectors, and those that have did not analyze industry characteristics that might explain inter-industry variation in IIT. Hence, the aim of this research has been to determine the extent of IIT in the U.S. processed food and beverage sectors and to find industry determinants of observed IIT.

Using a cross-section of SIC's, the extent of IIT in the U.S. processed food and beverage sectors for 1987 was estimated using the Grubel and Lloyd (GL) index. While previous studies (Hirschberg, *et al.;* Hart and McDonald) have measured IIT in these industries, neither used highly disaggregated SIC categories. The results of the calculations support the existence of IIT in the U.S. processed food and beverage sectors. While some categories exhibit almost pure IIT, the majority of the categories tend toward the lower values of the GL index; however, the variation in IIT across industries was considered sufficient to warrant further examination.

Based on the theory of IIT and previous empirical research, a reduced-form model explaining inter-industry variation in IIT was developed and tested using OLS. The results show that, for 1987, cross-industry variation in IIT in the U.S. processed food and beverage sectors was positively correlated to product differentiation, economies of scope, and similarity of tariff barriers, and negatively related to industry concentration. Future research in this area might focus on improving the measurement of explanatory variables such as product differentiation, and on how changes in industry variables affect changes in IIT over time. Also, an empirical methodology needs to be developed to allow researchers to discriminate more precisely between competing theories of IIT.

Finally, given that theory indicates that IIT may generate welfare gains over and above those from conventional comparative advantage (greater variety, greater realization of economies of scale, increased competition), some concluding remarks can be made with respect to the policy implications of this research. Specifically, it can be argued that trade liberalization in industries characterized by IIT is likely to generate greater gains relative to those industries where little IIT occurs. While the U.S. has several institutions in place to promote exports, e.g. the Export Enhancement Program, imports usually have restrictions placed on them such as tariffs and quotas. Hence, if the benefits from IIT are to be realized, then import barriers need to be removed, e.g. the cheese import quota regime. In this study, it was found that IIT in the food and beverages industry is positively correlated to the level of similarity of foreign and domestic tariff rates, and thus the extent of IIT could be increased from both the reduction of U.S. tariffs and equalization of tariff rates between the U.S. and its trading partners. Given the existence of both inter- and intra-industry trade, and given the gains from trade from both, if elimination of barriers to trade helps increase both types of trade, then there is all the more justification for reducing trade barriers. Furthermore, analyses of the impact of trade liberalization should take into account the existence of IIT in food processing when measuring the effects of structural adjustment. This seems particularly important in the light of the political debate over the proposed North American Free Trade Agreement (NAFTA).

References

Aquino, A. "Intra-Industry Trade and Inter-Industry Specialization as Concurrent Sources of International Trade in Manufactures." *Weltwirtschaftliches Archiv* 114(1978): 275–95.

Balassa, B. *Economic Development and Integration*. Centro de Estudios Monetarios Latinoamericos, Mexico (1965).

Balassa, B. "Intra-Industry Trade and the Integration of Developing Countries in the World Economy." Staff Working Paper 312, The World Bank (1979).

Balassa, B. "The Determinants of Intra-Industry Specialization in United States Trade." *Oxford Economic Papers* 38(1986):220–33.

Balassa, B., and L. Bauwens. "Intra-Industry Specialization in a Multi-Country and Multi-Industry Framework." *Economic Journal* 97(1987):923–39.

Baumol, W.J., E.E. Bailey, and R.D. Willig. "Weak Invisible Hand Theorems on the Sustainability of Multiproduct Natural Monopoly." *American Economic Review* 67(1977): 350–65.

Brander, J.A., and P. Krugman. "A Reciprocal Dumping Model of International Trade." *Journal of International Economics* 13(1983):313–21.

Caves, R.E. "Intra-Industry Trade and Market Structure in the Industrial Countries." *Oxford Economic Papers* 32(1981): 202–23.

Census of Manufactures–1987. Bureau of the Census. U.S. Department of Commerce. Industry Series MC87-1-20 A-I (1990) and MC87-S-6 (1992).

Christodoulou, M. "Intra-Industry Trade in Agrofood Sectors: The Case of the EEC Meat Market." *Applied Economics* 24(1992):875–84.

Connor, J.M., R.T. Rogers, B.W. Marion, and W.F. Mueller. *The Food Manufacturing Industries: Structures, Strategies, Performance, and Policies*. Massachusetts: Lexington (1985).

Cox, D., and R. Harris. "Trade Liberalization and Industrial Organization: Some Estimates for Canada." *Journal of Political Economy* 93(1985):115–45.

Dayton, J.R., and D.R. Henderson. "Patterns of World Trade in Processed Food." OP-32, NC-194, The Ohio State University (1992).

Dixit, A., and J.E. Stiglitz. "Monopolistic Competition and Optimum Product Diversity." *American Economic Review* 67(1977):297–332.

Drabek Z., and D. Greenaway. "Economic Integration and Intra-Industry Trade: The EEC and CMEA Compared." *Kyklos* 37(1984):444–69.

Falvey, R.E. "Commercial Policy and Intra-Industry Trade." *Journal of International Economics* 11(1981):491–511.

Food Marketing Review, 1988. Economic Research Service, USDA. Agricultural Economic Report No. 614 (1989).

Fung, K.C. "Collusive Intra-Industry Trade." *Canadian Journal of Economics* 24(1991):391–404.

Glejser, H., A. Jacquemin, and J. Petit. "Exports in an Imperfect Framework: An Analysis of 1,466 Exporters." *Quarterly Journal of Economics* 84(1980):507–24.

Greenaway, D., and C. Milner. "A Cross-Section Analysis of Intra-Industry Trade in the U.K." *European Economic Review* 25(1984):319–44.

Greenaway, D., and C. Milner. *The Economics of Intra-Industry Trade*. Oxford: Basil Blackwell (1986a).

Greenaway, D., and C. Milner. "Growth and Significance of Intra-Industry Trade." Paper presented at the International Economics Study Group (1986b).

Grubel, H.G., and P.J. Lloyd. *Intra-Industry Trade*. London: MacMillan (1975).

Hart, T., and B.J. McDonald. *Intra-Industry Trade Indexes for Canada, Mexico, and the United States, 1962–87*. Agriculture and Trade Analysis Division, Economic Research Service, USDA. Staff Report No. AGES9206 (1992).

Havrylyshyn, O., and E. Civan. "Intra-Industry Trade and the Stage of Development: A Regression Analysis of Industrial and Developing Countries" in *Intra-Industry Trade* edited by P.K.M. Thasrakan. Amsterdam: North Holland (1983).

Helpman, E. "International Trade in the Presence of Product Differentiation, Economies of Scale, and Monopolistic Competition." *Journal of International Economics* 11(1981):305–40.

Helpman, E. "Imperfect Competition and International Trade: Evidence from Fourteen Industrial Countries." *Journal of the Japanese and International Economies* 1(1987):62–81.

Helpman, E., and P.R. Krugman. *Market Structure and Foreign Trade*. Cambridge, MA: MIT Press (1985).

Helpman, E., and P.R. Krugman. *Trade Policy and Market Structure*. Cambridge, MA: MIT Press, (1989).

Hirschberg, J.G., I.M. Sheldon, and J.R. Dayton. "An Analysis of Bilateral Intra-Industry Trade in the Food Processing Sector." *Applied Economics* (forthcoming).

Krugman, P.R. "Increasing Returns, Monopolistic Competition and International Trade." *Journal of International Economics* 9(1979):469–79.

Krugman, P.R. "Scale Economies, Product Differentiation and the Pattern of Trade." *American Economic Review* 70(1980):950–9.

Krugman, P.R. "Intra-Industry Specialization and the Gains from Trade." *Journal of Political Economy* 89(1981): 959–73.

Lancaster, K. "Intra-Industry Trade under Perfect Monopolistic Competition." *Journal of International Economics* 10(1980):151–76.

Leamer, E.E. "Testing Trade Theory." Working Paper No. 3957, National Bureau of Economic Research (1992).

Lyons, B. "An Empirical Investigation of UK Manufacturing Trade with the World and the E.E.C.: 1968 and 1980" in *The Convergence of International and Domestic Markets*. edited by David Audretsch, Leo Sleuwaegen, and Hideki Yamawaki. North-Holland: Elsevier (1989).

McCorriston, S., and I.M. Sheldon. "Intra-Industry Trade and Specialization in Processed Agricultural Products: The Case of the U.S. and the E.C." *Review of Agricultural Economics* 13(1991):173–84.

Pagoulatos, E., and R. Sorenson. "Two Way International Trade: An Econometric Analysis." *Weltwirtschaftliches Archiv* 11(1975):454–65.

Posner, M.V. "International Trade and Technical Change." *Oxford Economic Papers* 13(1961):323–41.

Richardson, J.D. "Empirical Research on Trade Liberalization with Imperfect Competition: A Survey." *OECD Economic Studies* 12(1989):7–50.

Schmalensee, R. "Inter-Industry Studies of Structure and Performance." in *Handbook of Industrial Organization* edited by Richard Schmalensee and Robert D. Willig. Amersterdam: North-Holland (1989).

Sheldon, I.M. "Intra-Industry Trade and Specialization in Processed Agricultural Products: Theory and Issues." OP-2, NC-194, Ohio State University (1992).

Smith, A., and A. Venables. "Completing the Internal Market in the European Community-Some Industry Simulations." *European Economic Review*, 32(1988):1501–1525.

Spence, A.M. "Trade and Trade Policy with Differentiated Products." *Review of Economic Studies* 43(1976):217–36.

Sutton, J. *Sunk Costs and Market Structure*. Cambridge, MA: MIT Press (1991).

Tharakan, P.K.M. "Empirical Analyses of the Commodity Composition of Trade." in *Current Issues in International Trade* edited by David Greenaway. London: Macmillan.

Toh, K. "A Cross-Section Analysis of Intra-Industry Trade in U.S. Manufacturing Industries." *Weltwirtschaftliches Archiv* 118(1982):282–301.

United Nations External Trade Data. Statistical Office of the United Nations, New York (1989).

Venables, A., and A. Smith. "Trade and Industrial Policy under Imperfect Competition." *Economic Policy* 3(1986): 622–72.

Verdoorn, P.J. "The Intra-Bloc Trade of Benelux" in *Economic Consequences of Nations*, Proceedings of a Conference Held by the International Economic Association. London (1960).