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

by

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Abstract

This paper analyzes the determinants of variation across industries in levels of intra-industry trade (IIT) for a sample of 36 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, U.S. total trade, similarity of tariff barriers among trade partners, and economies of scope, 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, 1986), has become an increasingly important phenomenon in international trade (Verdoorn, 1960; Grubel and Lloyd, 1975). Traditional trade theory, which predicts countries will specialize in the production and export of goods that use their abundant

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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 Greenaway and Milner, 1986 for a survey). These theoretical developments have predominantly emphasized the existence of imperfect market structures, economies of scale, and product differentiation. 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).

Essentially, this type of model assumes all countries share the same technology: in 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. In the latter sector, free entry generates a market structure of monopolistic competition, while increasing returns limit the number of differentiated goods that can be produced under autarky. If trade is allowed, 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. Hence, given a demand for variety, 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). As a result, consumers benefit from greater variety. Further, economies of scale may be more fully realized, and prices of differentiated goods may fall. 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.

Along with the theoretical studies, several econometric studies of the determinants of IIT have been conducted, most of which tend to support the view that imperfect competition is a critical determining factor (see Greenaway and Milner, 1986, for a survey). Until recently, most studies have focussed attention on the manufacturing industries, by and large, the processed food and beverage industries being ignored. 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 market structures and produce heterogeneous goods. (For a thorough discussion of the food and beverage industries, see Connor, et al., 1985, and Sutton, 1991). In addition, IIT has been documented in the processed food and beverage industries (McCorriston and Sheldon, 1991; Hart and McDonald, 1992; Hirschberg, et al., 1992). As welfare gains from 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. While Hirschberg, et al., have studied the extent to which country characteristics explain the level of IIT in these industries over time, this study focusses on characteristics that determine the level of IIT across industries for a specific point in time for the United States.

The paper is organized as follows: in Section 1, the levels of IIT for the various food and beverage industries are calculated and discussed. Section 2 develops a simple model of the industry determinants of IIT based on theory and empirical studies for other industries. In Section 3, the results of cross-section analysis are discussed. Some concluding comments are 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 products (Grubel and Lloyd, 1975). A review of previous studies reveals that GL has been the predominant measure used, examples being Toh (1982) and Greenaway and Milner (1984). 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:

$$GL_i = \frac{(X_i + M_i) - |X_i - M_i|}{(X_i + M_i)} \qquad 0 \leq GL_i \leq 1 \quad (1)$$

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, 1986, 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 SICs, the SITC codes were converted to four-digit SIC codes using a concordance developed by Dayton and Henderson (1992). The industry codes for the food and beverage industries range from SIC 2011 to 2099; Table 1 contains code descriptions. 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; also, they constitute 92 percent of total world trade in processed food and beverage products. The data were taken from the reports of the importing countries, import data being 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.

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. 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 representative of ideas presented in IIT theoretical work. Beyond that, reviewing previous empirical work yields some additional suggestions. The determinants described below are those that were used in the final analysis. Other variables 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 introduction, product differentiation is considered by many researchers to be one of the key determinants of IIT; specifically, it has been hypothesized that IIT increases as the potential for product differentiation increases (Posner, 1961; Lancaster, 1980; Helpman, 1981). Support for this hypothesis can be found in several previous empirical studies, e.g., Pagoulatos and Sorenson (1975), Greenaway and Milner (1984), and Balassa and Bauwens (1987), among others.

In this study, the advertising/sales ratio (AS) was used to proxy product differentiation;[1] this measure is commonly used for this purpose in industrial organization research. *A priori*, the more money spent on advertising in an industry, the more differentiated are the products in that industry. The advertising data were taken from the *Food Marketing Review* (1988), and sales data were taken from the U.S. Census of Manufactures (1987). 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: Several studies have used seller concentration as an explanatory variable in analyzing IIT; various hypotheses are put forward to support such inclusion. First, if economies of scale exist in an industry, the number of firms in the industry is limited, meaning that concentration in that industry is likely to be relatively high. It is generally believed that if concentration is high, there is lack of product variety; lack of variety leads to product standardization, so IIT should be inversely related to concentration. Empirical

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.

support for this comes from Toh (1982), Balassa (1986), and Balassa and Bauwens (1987).

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, 1980; Lyons, 1989). 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 (1983) and Toh (1982), 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 (1992). HI is measured by squaring the market share for each of the top fifty companies in an industry and summing.

(iii) Similarity of Tariff Rates: It is generally hypothesized that IIT decreases with an increase in tariff rate dispersion, which is the difference between domestic and foreign tariff rates. Although no consistently strong indication of a positive or negative effect of tariffs has been found in previous studies, e.g., Caves (1981), Toh (1982) and Balassa and Bauwens (1987), Pagoulatos and Sorenson (1975) 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 in the analysis. Tariff data are sparse, and recent rates were unobtainable for foreign countries, the measure ultimately used being based on two sets of data. 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 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 is the following:

$$S_i = \frac{T_i^{US} + T_i^{FOR} - |T_i^{US} - T_i^{FOR}|}{(T_i^{US} + T_i^{FOR})} \qquad 0 \leq S_i \leq 1 \quad (2)$$

where the superscript US refers to U.S. tariffs and FOR to foreign tariffs in industry i. *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.

(iv) Economies of Scope: Caves (1981) 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. 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--as reported in the U.S. Census of Manufactures--of the shipment of primary products of industry i made by plants classified in that industry to total shipments by those plants. It is hypothesized that IIT in the U.S. food and beverage sectors is positively related to $(1-SP_i)=PS_i$. 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.

(v) U.S. Total Trade: U.S. total trade is hypothesized to be a determinant of IIT because the larger the amount of total trade in an industry, the more integrated the industry into the global economy, and thus, the greater the likelihood that IIT exists. A high volume of trade in an industry could indicate the existence of other countries with similar tastes and/or similar factor endowments influencing those tastes. (Conventional wisdom holds that there is a strong relationship between existence of an industry and existence of taste for goods in that industry.) If this is the case, then IIT is predicted to be positively related to U.S. total trade (US).

(vi) 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 theoretical expectations 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.

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 36 U.S. processed food and beverage industries in 1987. Other studies have used variations of OLS such as tobit (Hirschberg, et al., 1992) and logit (Caves, 1981). Tobit was used by Hirschberg, et al., because several of the observations for the dependent variable had zero values. The study here also has zero values for the dependent variable, but a preliminary test using tobit did not offer results significantly different from OLS. Caves used logit 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:

$$GL_i = \alpha_0 + \alpha_1 AS_i + \alpha_2 HI_i + \alpha_3 S_i + \alpha_4 PS_i + \alpha_5 US_i + \mu_i \tag{3}$$

where all variables are defined as above, the expected signs of the estimated coefficients are: α_1, α_3, α_4, $\alpha_5 > 0$; $\alpha_2 >$ or < 0; and μ_i is the error term.

(ii) Results: Table 2 reports the results of the OLS regression analysis adjusted for heteroskedasticity.[2] The model was significant at the 95 percent confidence level. Approximately 37 percent 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 90 percent 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 variables are unaffected by the removal of this observation.

Second, the estimated coefficient of the Herfindahl index (HI) was negative and significant at the 95 percent 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.

Table 2: OLS Results

Variable	Estimated Coefficient	T-Ratio	R^2	Adjusted R^2	F
Advertising/Sales	2.9742	1.6137	0.4633	0.3739	5.180
Herfindahl Index	$-0.14086\ 10^{-3}$	-2.1871			
Tariff Similarity	0.21005	2.1660			
Economies of Scope	$0.22515\ 10^{-1}$	2.7127			
U.S. Total Trade	$0.11078\ 10^{-6}$	4.2065			

Third, the estimated coefficient of the similarity of tariff barriers (S) was positive as predicted, and significant at the 95 percent confidence level. The existence of IIT in industries where the United States and its trading partners have similar tariffs is an indication that these countries are protecting similar industries and are likely to have similar tastes encouraging the existence of these industries.

Fourth, the estimated coefficient of economies of scope (PS) was significant at the 99 percent confidence level and was positive as predicted. If industries can produce multiple, differentiated goods due to economies of scope, IIT will likely occur.

Finally, the estimated coefficient of total U.S. trade (US) was significant at the 99 percent confidence level and positive as predicted. A large volume of trade indicates that an industry is highly integrated into the global economy which suggests that there are trade partners with similar preferences and/or resources, which could be indicative of taste overlap between the United States and its trading partners.

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 SICs, 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., 1992; Hart and McDonald (1992)) 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 showed that, for 1987, cross-industry variation in IIT in the U.S. processed food and beverage sectors was positively correlated to total U.S. trade, similarity of tariff barriers, economies of scope, and product differentiation, and negatively related to industry concentration.

Given the welfare implications of IIT (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. First, the positive relationship between IIT in the U.S. processed food and beverage sectors and total U.S. trade implies that beyond traditional welfare gains, free trade would also add the benefits from IIT, and thus both imports and exports should be encouraged. While the United States has several institutions in place to promote exports, imports usually have restrictions placed on them such as tariffs and quotas. If IIT is to be encouraged, then import barriers need to be removed so that gains can be realized. The relationship with total trade implies that tariffs inhibit IIT by limiting total trade. In addition, as IIT was found to be positively correlated to the level of similarity of foreign and domestic tariff rates, IIT would benefit from both the reduction of U.S. tariffs and equalization of tariff rates between the United States and its trading partners. Given the existence of both inter- and intra-industry trade, and given welfare gains with both, if elimination of barriers to trade helps increase both types of trade, then there is all the more justification for reducing trade barriers. One type of trade cannot be emphasized over the other; rather, all forms of market distortion should be removed.

Endnotes

[1]An alternative measure for product differentiation, the Hufbauer index, was tested but found to be insignificant. This measure has been criticized, however, for measuring technological differentiation or differences in inputs.

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

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