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A CROSS-SECTION ANALYSIS OF MULTILATERAL INTRA-INDUSTRY TRADE IN THE U.S. PROCESSED FOOD AND BEVERAGE SECTORS

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Abstract

This paper analyzes the determinants of inter-industry variation in levels of multilateral intra-industry trade 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 results of the analysis indicate that IIT variation across these industries is positively related to U.S. total trade, similarity of tariff barriers, 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 resources and import goods that use their scarce resources, cannot rationalize the existence of IIT. However, 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 being Krugman (1979), Dixit and Norman (1980), Lancaster (1980), and Helpman (1981).

Essentially, this type of model assumes all countries share the same technology, whereby in each economy, a perfectly competitive sector produces a homogeneous good under constant returns, 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 for, 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, depending on the precise specification, 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 these 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. However, 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 these industries are perfectly competitive. However, there is evidence that the food manufacturing industries exhibit various market structures and produce heterogeneous goods. (For a thorough discussion of the food manufacturing industries, see Connor, et al., 1985). 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 inter-industry variation in IIT at a specific point in time for one country.

The paper is organized as follows: in Section 1, the measurement of IIT is outlined along with a discussion of the results for the food and beverage industries. Section 2 develops a simple model of the industry determinants of IIT, while in Section 3, the results of cross-section analysis are discussed. Some concluding comments are made in Section 4.

1. Measurement of IIT

Various measures of IIT have been developed in the literature. In this study, the Grubel and Lloyd index (GL) has been selected for application to U.S. trade in 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 Lundberg (1982), Toh (1982), Gavelin and Lundberg (1983), Havrylyshyn and Civan (1983), Greenaway and Milner (1984), Messerlin and Becuwe (1986), Marvel and Ray (1987), Hart and McDonald (1992), Hirschberg, et al. (1992).

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:

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

$$GL_i = 1 - \frac{|X_i - M_i|}{(X_i + M_i)} \tag{2}$$

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, for purposes of this study, the SITC codes were converted to four-digit SIC codes using a concordance developed by Dayton and Henderson (1992). This was done because industry data used in the analysis are reported by SIC codes. The industry codes selected range from SIC 2011 to 2099. The four-digit classification was used for two reasons. First, it was necessary to minimize the possibility of categorical aggregation, which is the inappropriate grouping of trade categories for the purposes at hand[1]. Second, the data used for measuring industry variables could not be disaggregated beyond the four-digit level for most independent variables.

The measurement of GL_1 is based on U.S. multilateral trade with a select group of thirty countries. These thirty countries were chosen due to the consistency of their reporting of trade data. This subset constitutes 92% of total world trade in processed food products; thus, only a small percentage of trade is excluded, while the integrity of the study is maintained. Also, 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, the implementation of quotas, etc.

The estimates of GL_1 are reported in **Table 1** for the food and beverage industries in 1987. These estimates indicate that three SIC categories (2035, 2051, 2097) exhibit no IIT, while SIC categories 2011, 2021, 2043, and 2099 have very high values. The mean of the sample is 0.329 with a variance of 0.095. These results reinforce other evidence for the existence of IIT in the food and beverage industries.

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[1]While high levels of IIT can be attributed to high levels of categorical aggregation, Greenaway and Milner (1986) have shown that when comparing SITC three-digit level IIT figures to four-digit level IIT figures (SITC 0-8), the expected decline (caused by lessening of categorical aggregation) is minimal so that even the three-digit level serves well in studying IIT. However, the same may not hold in the case of SIC classification due to differences in aggregation schemes.

Table 1: U.S. Trade, 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

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

In choosing the 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.

(i) Product Differentiation (HU, AS)

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), amongst others.

In this study, two measures of product differentiation have been used. The first measure is the Hufbauer index (HU) which has been used in several previous studies, e.g., Balassa and Bauwens, op.cit.. HU is the standard deviation of export unit values for shipments of good i to country j, divided by the unweighted mean of those unit values. This index is supposed to measure differentiation by showing the variations of export prices to different countries. Criticism of this measure lies in the fact that it might also be a measure of technological differentiation or differences in inputs rather than horizontal or vertical differentiation[2]. Presumably, as well, price differences may be due to other factors such as transport costs, etc. In order to alleviate this problem, U.S. export quantities and values were used (meaning HU should consist of f.o.b. unit values); at any rate, the need for export data is inherent in the

[2]Horizontal differentiation refers to differentiation in actual or perceived characteristics. Vertical differentiation refers to differentiation in quality.

definition of the variable. The UN data series were used to construct HU, and U.S. reported export data were used for eighteen countries. The countries used were Austria, Belgium/Luxembourg, Canada, Denmark, France, Greece, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and West Germany; these were selected due to the availability of value and quantity data for U.S. exports.

The second measure (AS) used to proxy product differentiation is the advertising/sales ratio, which has been commonly used in industrial organization research. 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) Economies of Scale (MES)

As noted earlier, it is expected that IIT exists in commodities for which scale economies are possible (Drèze, 1960, 1961; Lancaster, 1980; Helpman, 1981; Krugman, 1981). Where scale economies occur, each country has only a limited capacity to produce goods in a specific industry, so that with IIT, each country produces and exports a specific range of goods and imports other varieties; hence, consumers have more varieties from which to choose than under autarky. Previous empirical research, though, has generated conflicting results about this factor. Greenaway and Milner (1984) found IIT to be positively and significantly correlated to the potential for scale economies; whereas, Caves (1981) found that the more extensive are scale economies, the lower the level of IIT. Importantly, both Caves, and Greenaway and Milner expected a negative relationship, meaning that when minimum efficient scale (MES) was large relative to the total market, cost conditions limit the number of firms which leads to either complete homogeneity of products or a major constraint to the number of available varieties. However, according to Greenaway and Milner's findings, a low MES indicates that most varieties can be produced domestically and IIT is not encouraged. In this study, MES is used as a proxy for the extent of scale economies. MES is defined as the smallest sized plant at which minimum unit costs are achieved (Connor, et al., 1985)[3]. To obtain this measure, data from the U.S. Census of Manufactures (1987) were used.

(iii) Concentration (C4, HI)

Several studies have used seller concentration as an explanatory variable in analyzing IIT, various hypotheses 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 that IIT should be inversely related to concentration. Empirical support for this hypothesis 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.

[3]MES is the percentage of total industry value-added attributed to the plant-size estimated to be at the mid-point of the value-added distribution, expressed as value-added per employee, where MES=E as % of A, A=total value-added, A/2=midpoint plant value-added, B=employment interval that includes A/2, C=average number of employees per plant in interval B, D=value-added per employee in interval B, and E=C*D.

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 play a Stackelberg strategy against 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 manufacturing sector, four-firm concentration ratios (C4) and the Herfindahl-Hirschmann (HI) index[4] are used, the data coming directly from the Census of Manufactures (1992).

(iv) Tariff Rates (HA, SA)

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 has been found in previous studies, e.g., Caves (1981), Toh (1982) and Balassa and Bauwens, op.cit., it was felt that, given the level of protection for the food and beverage sectors, some form of tariff measurement was needed in the analysis. Tariff data are sparse, and recent rates were unobtainable for foreign countries, the measures 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

[4]The Herfindahl-Hirschmann index is measured by squaring the market share for each of the top fifty companies in an industry and summing.

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.

Two indices of tariff rates were developed in the analysis. First, an index of the average of U.S. and foreign tariff rates was constructed; this is a measure of the height of tariff barriers (HA), where it is predicted that IIT will be negatively related to the height of tariff barriers in the U.S. food and beverage sectors, as tariffs are expected to restrict trade. Second, a measure of similarity of tariff barriers (SA) was used:

$$S_i = \frac{T_i^{US} + T_i^{FOR} - |T_i^{US} - T_i^{FOR}|}{(T_i^{US} + T_i^{FOR})} \qquad 0 \leq S_i \leq 1 \qquad (3)$$

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 have similar resource endowments and similar tastes; hence, IIT would occur among these countries (Pagoulatos and Sorenson, 1975).

(v) Categorical Aggregation (CA)

As noted earlier, categorical aggregation is often expected to be an underlying explanation for observed IIT, due to inappropriate grouping of product categories. Numerous researchers have proxied this in order to determine its significance in the amount of trade overlap. Previously documented empirical work reinforces the need for the most disaggregated data available to eliminate as much of the effects of categorical aggregation as possible (Toh, 1982).

Following previous empirical work, a simple measure has been utilized in this study. For each four-digit classification, the number of five-digit classifications has been used as a measure of categorical aggregation (CA). While it is argued by some that this is a measure of product differentiation, there is the assumption that the Census classification is designed in such a manner that different, not differentiated, products are placed in separate classifications, and that products with the same inputs and end use (i.e., differentiated) are placed in the same classification. It is hypothesized that the higher the number of five-digit classifications within a four-digit classification, the higher the calculated level of IIT.

(vi) Economies of Scope (PS, OC)

Caves (1981) has analyzed the possible impact of economies of scope on IIT. To illustrate economies of scope, an example is helpful. In a two-country, two-product setting, joint production can lead to IIT. Country A has a comparative advantage in producing curds compared to country B, while country B has a comparative advantage in producing whey due to differences in technology and cows. In the process of producing curds (whey), however, country A (B) also produces whey (curds). While A (B) might not have a comparative advantage in whey (curds), it will, nonetheless, produce and possibly export whey (curds) along with curds (whey). Thus, IIT could increase as joint production possibilities increase. Caves used the following measure (SCOPE) to test this possibility:

$$SCOPE_i = 2 - SP_i - CO_i \tag{4}$$

SP_i (specialization) 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, and CO_i (coverage) equals the ratio of shipments of primary products of industry i made by plants classified in that industry to total shipments of products classified in that industry.

For this study, Caves' measure is altered. Specialization and coverage are variations on the concept of economies of scope; combining them hides their possible individual impact on IIT. By separating the two measures, the concept remains unchanged, but the individual results will be obvious. SP and CO are treated separately; each is subtracted from one. The data come directly from the U.S. Census of Manufactures. It is hypothesized that IIT in the U.S. food and beverage sectors is positively related to PS=(1-SP) and to OC=(1-CO). PS 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. OC is the ratio of shipments of primary products of an industry made by plants outside of that industry to total shipments of products classified in that industry.

(vii) U.S. Total Trade (US)

U.S. total trade is used as a determinant of IIT in this study as it is hypothesized that a high volume of trade in a category would indicate the existence of other countries with similar tastes and possibly similar factor endowments influencing these tastes. If this is the case, then IIT is predicted to be positively related to U.S. total trade (US).

(viii) Seasonality (SE)

The final variable used in this study is seasonality. Seasonality affects trade in that, countries with different growing seasons for a good will tend to export that good during that country's growing season and import that good during its off season. This can be argued not to be a factor of IIT as the overlapping trade does not occur concurrently; rather, the resulting IIT figure is due to seasonal fluctuations in production. To account for seasonality, a dummy variable (SE) was utilized. A measure of 1 for SE indicated goods whose production was highly correlated to seasonality; these are mainly products derived from fruits and vegetables. A measure of 0 for SE indicated that seasonality effects were considered to be negligible; this would be expected in highly processed goods. While this index is crude, it nonetheless attempts to account for the factor of seasonality which some would argue is highly prevalent in the food and beverage sectors. A measure that accounts for differences in the seasonality of the trading partners would perhaps be more appropriate; however, it was not possible to construct such a measure with the available data. It is hypothesized for this model that IIT will correspond positively with SE.

3. Empirical Methodology and Results

(i) Estimated Model

Based on the determinants discussed in Section 2, the model tested is summarized as:

$$GL_i = f(HU_i, AS_i, MES_i, C4_i, HI_i, HA_i, SA_i, CA_i, PS_i, OC_i, US_i, SE_i) \qquad (5)$$

All equations in the following analysis were 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[5]. Other studies have utilized 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 (see earlier definition of the GL index of IIT); the study herein also has zero values for the dependent variable in the 1987 data. A tobit regression was run in preliminary tests, but the results did not offer anything significantly different from OLS. Logit was used by Caves because he reasoned that, since the dependent

[5]The econometrics package Shazam (White, et al., 1990) was used.

variable was 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. Since the purpose of this study is to explain and not predict IIT, the use of logit was deemed unnecessary (Greenaway and Milner, 1984); also, there are no values at the upper limit in this sample.

Initially, multicollinearity amongst the variables was tested for, and, in order to reduce this problem, several different combinations of independent variables were used so that highly correlated variables were not tested together. First, OC was eliminated. It was highly correlated with HU and PS and was a measure very similar to PS. Preliminary tests showed that it was insignificant. Second, MES, C4, and HI were used separately from each other as there was some multicollinearity among them. They are variations of similar concepts, so separating them can aid in determining the best measure. In addition, HU and AS were used separately since they were both measures of product differentiation.

Ultimately, six different combinations of independent variables were tested. The equations are as follows:

$$GL_i=\alpha_0+\alpha_1AS_i+\alpha_2MES_i+\alpha_3HA_i+\alpha_4SA_i+\alpha_5CA_i+\alpha_6PS_i+\alpha_7US_i+\alpha_8SE_i+\mu_i \quad (6)$$

$$GL_i=\alpha_0+\alpha_1AS_i+\alpha_9C4_i+\alpha_3HA_i+\alpha_4SA_i+\alpha_5CA_i+\alpha_6PS_i+\alpha_7US_i+\alpha_8SE_i+\mu_i \quad (7)$$

$$GL_i=\alpha_0+\alpha_1AS_i+\alpha_{10}HI_i+\alpha_3HA_i+\alpha_4SA_i+\alpha_5CA_i+\alpha_6PS_i+\alpha_7US_i+\alpha_8SE_i+\mu_i \quad (8)$$

$$GL_i=\alpha_0+\alpha_{11}HU_i+\alpha_2MES_i+\alpha_3HA_i+\alpha_4SA_i+\alpha_5CA_i+\alpha_6PS_i+\alpha_7US_i+\alpha_8SE_i+\mu_i \quad (9)$$

$$GL_i=\alpha_0+\alpha_{11}HU_i+\alpha_9C4_i+\alpha_3HA_i+\alpha_4SA_i+\alpha_5CA_i+\alpha_6PS_i+\alpha_7US_i+\alpha_8SE_i+\mu_i \quad (10)$$

$$GL_i=\alpha_0+\alpha_{11}HU_i+\alpha_{10}HI_i+\alpha_3HA_i+\alpha_4SA_i+\alpha_5CA_i+\alpha_6PS_i+\alpha_7US_i+\alpha_8SE_i+\mu_i \quad (11)$$

where all variables are defined as above, μ_i is the error term, and the expected signs of the estimated coefficients are:

$$\alpha_1, \alpha_2, \alpha_4, \alpha_5, \alpha_6, \alpha_7, \alpha_8, \alpha_{11} > 0; \ \alpha_3 < 0; \ \alpha_9, \alpha_{10} \gtrless 0.$$

(ii) Results

Tables 2 and **3** report the results of the regression analysis adjusted for heteroskedasticity[6]. Outliers were tested for, and one observation was found to be extremely influential. SIC 2043 (breakfast cereals) had an outlier in the advertising/sales ratio. To show the effects of this outlier, the models were run with and without this observation. **Table 2** contains the results for tests without this observation; **Table 3** shows the results when all thirty-six observations were used. All models ultimately tested are significant at the 95% confidence level. Only the results for the models with 35 variables are discussed here as they are considered to be more representative of the U.S. food and beverage industries as a whole.

- In the first model, the estimated coefficients of US and SA are significant at the 99% confidence level with the expected positive signs. The estimated coefficient of PS is significant at the 95% confidence level with the expected sign.

- The second model has the estimated coefficient of US significant and positive at the 99% confidence level. Two other positive estimated coefficients (SA, PS) and one negative estimated coefficient (C4) are significant at the 95% confidence level, all with the expected signs.

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[6]Heteroskedasticity was tested for using the seven tests included in the Shazam program (see White, et al., 1990).

Table 2: OLS Results with 35 Observations

Eqn.	AS	MES	HA	SA	CA	PS	US	SE	C4	HI	HU	R^2	adj. R^2	F
6.	-0.391	-0.811	-0.736^{-2}	0.352	0.165^{-1}	0.173^{-1}	0.940^{-7}	-0.125				0.4911	0.3346	3.137
	(-0.163)	(-0.642)	(-0.816)	(2.626)	(1.117)	(2.104)	(4.400)	(-1.114)						
7.	0.202		-0.440^{-2}	0.301	0.129^{-1}	0.176^{-1}	0.901^{-7}	-0.993^{-1}	-0.367^{-2}			0.5246	0.3783	3.587
	(0.972^{-1})		(-0.710)	(2.328)	(0.946)	(2.177)	(3.958)	(-0.909)	(-2.027)					
8.	0.110^{-1}		-0.463^{-2}	0.309	0.139^{-1}	0.177^{-1}	0.920^{-7}	-0.115		-0.958^{-4}		0.5127	0.3628	3.420
	(0.530^{-2})		(-0.733)	(2.369)	(1.013)	(2.167)	(4.181)	(-1.074)		(-1.652)				
9.		-1.119	-0.923^{-2}	0.370	0.171^{-1}	0.182^{-1}	0.952^{-7}	-0.133			-0.100	0.4975	0.3429	3.218
		(-1.034)	-(1.539)	(2.677)	(1.139)	(2.309)	(4.422)	(-1.363)			(-0.697)			
10.			-0.453^{-2}	0.311	0.135^{-1}	0.181^{-1}	0.914^{-7}	-0.117	-0.384^{-2}		-0.106	0.5323	0.3883	3.698
			(-0.847)	(2.424)	(0.968)	(2.398)	(3.901)	(-1.253)	(-2.524)		(-0.875)			
11.			-0.503^{-2}	0.319	0.147^{-1}	0.184^{-1}	0.931^{-7}	-0.130		-0.102^{-3}	-0.993^{-1}	0.5196	0.3718	3.515
			(-0.947)	(2.451)	(1.040)	(2.381)	(4.128)	(-1.383)		(-2.043)	(-0.786)			

Figures in parentheses are t-ratios

Table 3: OLS Results with 36 Observations

Eqn.	AS	MES	HA	SA	CA	PS	US	SE	C4	HI	HU	R^2	adj. R^2	F
6.	2.878	-1.527	-0.140^{-1}	0.351	0.161^{-1}	0.210^{-1}	0.933^{-7}	-0.854^{-1}				0.5091	0.3636	3.500
	(1.722)	(-1.335)	(-2.222)	(2.554)	(1.118)	(2.675)	(4.202)	(-0.756)						
7.	3.434		-0.925^{-2}	0.282	0.144^{-1}	0.213^{-1}	0.891^{-7}	-0.695^{-1}	-0.377^{-2}			0.5279	0.3881	3.775
	(1.852)		(-1.580)	(2.073)	(1.048)	(2.695)	(3.721)	(-0.616)	(-1.881)					
8.	3.244		-0.947^{-2}	0.291	0.154^{-1}	0.215^{-1}	0.909^{-7}	-0.852^{-1}		-0.100^{-3}		0.5178	0.3749	3.624
	(1.773)		(-1.618)	(2.110)	(1.109)	(2.671)	(3.886)	(-0.773)		(-1.580)				
9.		-0.958	-0.834^{-2}	0.322	0.130^{-1}	0.229^{-1}	0.974^{-7}	-0.146			-0.991^{-1}	0.4774	0.3226	3.083
		(-0.862)	(-1.417)	(2.226)	(0.853)	(2.818)	(4.229)	(-1.399)			(-0.706)			
10.			-0.487^{-2}	0.278	0.116^{-1}	0.231^{-1}	0.952^{-7}	-0.142	-0.209^{-2}		-0.923^{-1}	0.4834	0.3303	3.158
			(-0.874)	(2.043)	(0.819)	(2.896)	(3.881)	(-1.367)	(-1.030)		(-0.743)			
11.			-0.523 -2	0.285	0.127^{-1}	0.230^{-1}	0.961^{-7}	-0.149		-0.503^{-4}	-0.873^{-1}	0.4780	0.3233	3.090
			(-0.932)	(2.065)	(0.888)	(2.858)	(4.032)	(-1.453)		(-0.781)	(-0.677)			

Figures in parentheses are t-ratios

- The estimated coefficient of US is, once again, significant and positive at the 99% confidence level in the third model. The estimated coefficients of SA and PS are significantly positive at the 95% confidence level, and the estimated coefficient of HI is significantly negative at the 90% confidence level.

- The fourth model has the estimated coefficients of US and SA significant and positive at the 99% confidence level, with the estimated coefficient of PS significant at the 99% confidence level.

- In the fifth model, there are the same three positive significant estimated coefficients (US at the 99% confidence level and SA and PS at the 95% confidence level) along with C4 which has a significant negative estimated coefficient at the 99% confidence level.

-Finally, in the last model, the estimated coefficient that is significant at the 99% confidence level is US. The estimated coefficients of SA and PS (positive) and HI (negative) are significant at the 95% confidence level.

In summarizing the six models, it can be seen that the estimated coefficients for the independent variables US (U.S. total trade), SA (similarity of tariff barriers), and PS (economies of scope) are consistently significant. C4 (four-firm concentration) and HI (Hirschmann-Herfindahl index) were tested in only two models, and their estimated coefficients were significant both times. The estimated coefficients of HU, AS, MES, HA, CA, and SE were consistently insignificant.

A number of comments can be made about these results. First, the estimated coefficient of total U.S. trade was significant and positive, as predicted. A large volume of trade suggests that there are trade partners with similar preferences and/or resources, which could be indicative of taste overlap between the U.S. and its trading partners.

Second, while the estimated coefficient of average height of tariff barriers was not significant, the similarity of tariff barriers was significant and positive as predicted. Following the arguments of Pagoulatos and Sorenson, op.cit., this appears to confirm that IIT occurs among countries with similar resource endowments and tastes.

Third, the estimated coefficient of economies of scope was significant and positive, as predicted. Fourth, the estimated coefficients of product differentiation and economies of scale, both significant variables in previous studies, were insignificant in all cases. However, the estimated coefficients of concentration were found to be negative and significant; while this could be interpreted in terms of scale economies or product standardization, the lack of statistical significance associated with other measures of these phenomena (MES, HU, AS) lends credence to the alternative interpretation based on market power, i.e., market power discourages IIT. Fifth, the estimated coefficients of categorical aggregation and seasonality were insignificant. These findings add to the body of evidence that IIT is not just a statistical phenomenon.

4. Summary

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 was to determine the extent of IIT in the U.S. processed food and beverage sectors and to find industry determinants of this 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., 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 was developed and tested using OLS. The results show that, for 1987, IIT in the U.S. processed food and beverage sectors was positively correlated to total U.S. trade, similarity of tariff barriers, and economies of scope, and negatively related to industry concentration. Other variables used were found to be statistically insignificant.

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 both imports and exports should be encouraged. While the U.S. 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 liberalized so that consumers can gain from increased choice. The relationship with total trade implies that tariffs limit the amount of IIT. 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 U.S. and its trading partners. Given the existence of both inter- and intra-industry trade, and given welfare gains from both, if elimination of barriers to trade will help 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, market distortions should be removed so that an equilibrium structure of trade can be reached.

Finally, given the importance attributed by Hirschberg, et al. (1992) to country characteristics in explaining cross-country variation of IIT in the processed food and beverage sectors, and the importance of industry characteristics established in this study, it would be interesting in future research to combine these two sets of factors in a cross-country, cross-industry analysis of IIT. In addition, as in the study by Hirschberg, et al., an expansion of this study over time would detail the stability of the industry determinants for these industries.

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